



Willingness to Pay for Pedestrian Crossing Management to the Elderly in Bangkok

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Abstract

Pedestrian crossing in the city is essential for the elderly, especially when Thailand is approaching aging society. This paper aimed at 1) investigating the behavior and opinion to use the pedestrian crossings of people in Bangkok and 2) evaluating the benefits obtained from the appropriate pedestrian crossings management for the elderly in Bangkok by applying contingent valuation method (CVM). It was found that most respondents use the pedestrian overpass rather than the jaywalking. They agreed that the jaywalking was not appropriate for the elderly because there were no traffic lights at the jaywalking. The average value of WTP for the arrangement of the proper pedestrian crossings in Bangkok for the elderly was equal to 1,396 baht/person/year. Therefore, the benefits obtained from the pedestrian crossings for the elderly in Bangkok in 2020 was at approximately 5,600 million baht/year.

Keywords: 1) Willingness to Pay 2) The Elderly 3) Pedestrian Crossing Management
4) Contingent Valuation Method (CVM)

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Introduction

Since 2005, the changing demographic structure in Thailand has resulted in an ageing society, as defined by the United Nations (United Nations, 2017). The proportion of the population aged 60 and over has been growing and is now 10 percent of the population. It is estimated that Thailand will be a full-fledged aged society in 2023, because by then the proportion of the population aged 60 and over will be 20 percent (Office of the National Economic and Social Development Council, 2019, p. 8). In addition, such demographic change would affect development in several areas, especially basic public utilities that must be able to support the ageing population. Unlike other age groups, the elderly, with deteriorating physical condition, must deal with declining performance and limited ability to use public utilities.

Taking this changing trend into account, Bangkok, the capital and development center for various areas of Thailand, realizes the need for changes and to manipulate the city to be friendly to all groups of residents, including an effort to develop the city to accommodate the aged society. This is well reflected in the 20-year development plan for Bangkok (2013-2032), aiming to develop Bangkok as a metropolis for everyone. One of the strategies is providing facilities and welfare for the elderly, the disabled, and the disadvantaged to attain the goal by 2032 that the elderly, the disabled, and the disadvantaged will be provided with social welfare, utilities, and basic facilities, to allow them to live their lives with dignity. The stated guidelines of the Bangkok Metropolitan Administration (BMA)

are also in line with the Livable City and Global Age-friendly Cities guidelines, set by the World Health Organization (2007).

However, even though the BMA Development Plan has an explicit goal for city development to make it a metropolis for everyone, it was found that the elderly in Bangkok have faced problems in using public utilities and basic facilities associated with the infrastructure being inefficient and impractical. In particular, they cannot agilely use pedestrian crossings (such as pedestrian overpasses or road tunnels) compared to other age groups of people, because of the deterioration in their physical condition. In addition, crossings are difficult and risky for the elderly. The study on The Arrangement of Bangkok Metropolitan Administration's Public Facilities and Services to Accommodate the Aging Society (Bejranonda, Laksanacom and Tantiwat, 2019, pp. 398-417) revealed that safe and proper pedestrian crossings were the most desirable public utilities for the elderly after safe pavements. This finding implied that the current situation of pedestrian crossings in Bangkok is dangerous and even life-threatening for the elderly. In addition, a report of the National Health Security Office (NHSO) indicated that Thai pedestrians accounted for 8.6 percent of those killed or injured annually between 2015 and 2018. Furthermore, the injured elderly aged above 65 had a higher fatality rate than all other age groups. The fatality rate of road accident victims was in descending order by age. In other words, younger victims had a lower fatality rate than older ones. Crossing roads caused damage to life and property every year.

As a result, all people in Bangkok, regardless of age, should participate in expressing their satisfaction of the benefits obtained from zebra crossings as a part of their participation in urban development, especially as there are 1,112 ground-level zebra crossings in Bangkok (Kwanmuang, 2020). The results of such input should improve the quality of life of people in Bangkok. The concerned government agencies would also benefit by having guidelines for the appropriate management of pedestrian crossings by the elderly.

From the above problems and information, this research aimed to: 1) investigate the behavior of use and opinions toward zebra crossings of the people in Bangkok; and 2) estimate the willingness of people to pay for pedestrian crossing management for the elderly and the benefits obtained. The economic theory of willingness-to-pay measurement was applied for valuing the willingness-to-pay for appropriate pedestrian crossing management. The results of the research should serve as guidelines for policy formulation concerning pedestrian crossing management for the elderly, in connection with the strategy to make Bangkok a livable city and a metropolis for all groups with a better standard of living.

Literature Review

A pedestrian crossing is considered a public utility, provided by the government, from which people as well as the society directly gain benefits, both at present and in the future. Consequently, pedestrian crossing management should be inclusive of people,

as stakeholders, to play their role and take part in expressing opinions and suggestions. However, as a pedestrian crossing is a public good without a clear market price that can be charged for using other typical services in the market system, the economics technique of the Contingent Valuation Method (CVM) was applied to assess the benefits derived from the use of pedestrian crossings.

In principle, CVM is a nonmarket valuation method, used to estimate the value of natural and environmental resources. It has been applied in studies of public goods and services valuation, such as a pedestrian pavement (Bejranonda, Laksanacom and Tantiwat, 2019, pp. 398-417) and outdoor exercise equipment (Bejranonda, 2019, pp. 1-18). The CVM approach is based on questions made under hypothetical circumstances related to the service to ask the respondents whether they would willingly contribute to obtain benefits from such a service. Their willingness can be described in terms of value Hanemann, Loomis and Kannines (1991, pp. 1225-1263). Mitchell and Carson (1989, pp. 17-40) explained that each individual user will make a decision based on a particular reason to use the service, so as to derive the greatest satisfaction under budgetary or financial limitations. Therefore, the Indirect Utility Function (V) can be illustrated using equation (1).

$$\begin{aligned} V[Q(P,Y),S; c] &= V[Q(P,Y),S; c] + \mu \\ &= V[P,Y,S; c] + \mu \quad \text{--- (1)} \end{aligned}$$

where Q is the good/service with a market price; P is the price of the good/service in the market; Y is the income; S is the quantity/quality of public services without an



explicit price charged; c is the socio-economic characteristics of the users; and μ is an error term. When the quantity/quality of the public service (S) changes, the utility in equation (1) will also change as shown in (2).

$$V_0[P, Y, S_0; c] + \mu_0 < V_1[P, Y, S_1; c] + \mu_1 \quad \text{---- (2)}$$

where S_0 and S_1 are the level of quantity/quality of the public service before and after the change, and V_0 and V_1 are the levels of utility before and after the change. As change in utility level assessment cannot be carried out, monetary assessment has been applied to explain such changes in the utility level. Assuming A is the amount that public service users are willing to pay to improve the quantity/quality of public service improvement, from S_0 to S_1 , it can be expressed using equations (3) and (4).

$$V_0[P, Y, S_0; c] + \mu_0 \leq V_1[P, Y - A, S_1; c] + \mu_1 \quad \text{---- (3)}$$

$$\text{or } [V_1(P, Y - A, S_1; c) - V_0(P, Y, S_0; c)] \geq (\mu_0 - \mu_1) \quad \text{---- (4)}$$

where $\mu = (\mu_0 - \mu_1)$ represents the random variable whose value is unknown in the indirect utility function. There is an assumption that the users will answer that they are willing to pay (Yes) and they are not willing to pay (No) according to the proposed amount (A). Therefore, the value obtained from a user's response is a random variable as well. The probabilities can be calculated using equations (5) and (6)

$$P_1 = \text{Prob}\{\text{users are willing to pay}\} = \text{Prob}\{\text{Yes}\}$$

$$= \text{Prob}\{[V_1(P, Y - A, S_1; c) + \mu_1] \geq [V_0(P, Y, S_0; c) + \mu_0]\}$$

$$P_1 = \text{Prob}\{[V_1(P, Y - A, S_1; c) - V_0(P, Y, S_0; c)] \geq (\mu_0 - \mu_1)\}$$

$$P_1 = \text{Prob}\{\Delta V \geq \mu\} \quad \text{---- (5)}$$

and

$$P_0 = \text{Prob}\{\text{users are not willing to pay}\}$$

$$P_0 = \text{Prob}\{\text{No}\}$$

$$P_0 = 1 - \text{Prob}\{\text{Yes}\} = 1 - P_1 \quad \text{---- (6)}$$

where $\Delta V = (V_1 - V_0)$ represents the difference in social welfare caused by the change in the quantity/quality of the public service if the user is willing to pay at least A baht for the public service improvement, then the user accepts the monetary value of A baht. Accordingly, the probability that the user accepts the value of A baht can be written as a cumulative distribution function in equation (7).

$$P_1 = \text{Prob}\{\Delta V \geq \mu\} = \text{Prob}\{\text{Yes}\}$$

$$P_1 = F_{\mu}\{\Delta V(\cdot)\}$$

$$P_1 = \text{Prob}\{\text{WTP} \geq A\}$$

$$P_1 = 1 - G(A) \quad \text{---- (7)}$$

Assign $F_{\mu}\{\Delta V(\cdot)\}$ to represent the cumulative distribution function; $G(A)$ as the cumulative distribution function. When the users do not accept the proposed initial amount, the estimation of average expected willingness to pay of the users (Mean WTP) can be expressed as equation (8).

$$E(\text{WTP}) = \int_0^{\infty} [1 - G(A)] dA \quad \text{---- (8)}$$

Hanemann (1984, pp. 332-341) indicated that WTP is a continuous random variable determined by two independent variables: 1) apparent attributes of users, such as gender, income or other socio-economic attributes; and 2) other variables that cannot be indicated by statistical models, such as taste or preference. Therefore, the user utility can be expressed by the random utility function, shown as equation (9).

$$\text{WTP} = X\beta + \mu \quad \text{---- (9)}$$

where WTP is the consumer's willingness-to-pay vector; X_j is the vector of independent variables, such as the socio-economic characteristics of the respondents; β is the coefficient vector; and μ is the random variance vector. Equation (9)

was used in the analysis for estimating the willingness-to-pay for zebra crossing management for use by the elderly in Bangkok.

Kanitpong (2018, pp. 12-16) indicated that there were 2 types of pedestrian different level crossing (overpasses or underpasses/tunnels) and crossing at ground level (zebra crossing). Referring to the studies concerning pedestrian crossings at ground level, Chumuenwai and Thanasupsin (2019, pp. 210-221), observing the road crossing habits of people in Bangkok, found that the proper design of crossing signal light should consider the start-up lost time of pedestrians, the walking speed of pedestrians, and the time headway of pedestrians. Similarly, the study of Asaithambi, Kuttan and Chandra (2016) found that signalized crossing resulted in a reduction in the average speed of pedestrians and a longer waiting time to cross the road. The timing of crossing the road depended on gender, age, road crossing pattern, and the speed of the approaching cars. Female pedestrians crossed the road more slowly than males as they had a deeper awareness of safety. In addition, a study on satisfaction of use of intelligent signalized crossing systems, conducted by Laosirihongthong, Changjob and Charusirisombat (2013, pp. 9-12) found that most pedestrians were not facilitated by intelligent signals. The waiting time to cross the road was also not reduced. Furthermore, the motorists did not stop their vehicles when the signal light turned red to yield to pedestrians crossing the road. In contrast, Anciaes and Jones (2018, pp.222-237) found that people preferred signalized

pedestrian crossings rather than overpasses or underpasses. However most of the previous studies involved engineering, behavioral, and satisfaction research, which did not apply the economic technique of willingness-to-pay for pedestrian crossing management, as in this study.

Methods

The population of this research was people, aged 25 and over, who lived in Bangkok because they are likely to be employed or have worked, and experienced or have used pedestrian crossings. Because of the unknown total population size, the sample size was determined by the model referred to by Sangkaew (1997, p. 57), hence, the minimum sample size for the research was 384. However, extra samples were included up to 437 in order to increase precision and lower the variability of the sampling distribution. The data were collected in April 2020 by interviewing the samples in public areas such as public parks, bus stops, and the forecourt of shopping malls.

Prior to the actual survey using the questionnaire to collect data, pretesting was undertaken to determine the initial price (Starting Bid) by asking a sample of 30 respondents an open-ended question about their willingness-to-pay for zebra crossing management for the use of the elderly. The hypothetical scenario described to the respondents was the Bangkok Metropolitan Administration (BMA) having a project to facilitate pedestrians, especially the elderly, to cross roads by installing signal lights at zebra crossing areas, but the budget was insufficient. Considering the benefits of the



project, the respondents were asked for their willingness-to-pay to contribute to the zebra crossing management in this project. The respondents could independently determine the price reflecting their willingness-to-pay. The price, gathered from the pretest, was determined as the initial amount (price) in the actual questionnaire for the survey. The pretest showed that most respondents gave one of four prices, which were 100, 200, 300 and 500 baht per person per year.

The actual questionnaire, containing the price, initially marked to elicit the willingness-to-pay of the respondents, was produced in similar sets of four double-bounded, close-ended questions. Each questionnaire offered different starting prices (100, 200, 300 and 500 baht per person per year). If the respondents accepted the starting price in each set of questionnaires, two times as many of the starting prices were proposed to check whether they would still purchase or not. On the other hand, if the respondents rejected the starting price, the interviewer proposed the half price as well.

The actual questionnaire asked about: 1) behavior of using a pedestrian crossing and zebra crossing in Bangkok, consisting of behavior when walking across the road in everyday life, methods of road crossing, feeling of safety regarding crossing the road, using a zebra crossing to cross the road, reasons to use/not a use zebra crossing, using zebra crossing behavior, pedestrian accidents on zebra crossings, feeling of safety while using zebra crossings, suitability and practicality of zebra crossing conditions; 2) problems in using zebra crossings; 3) the importance level attached to the role and function of

zebra crossings in Bangkok; 4) knowledge and understanding of zebra crossings; 5) willingness-to-pay for zebra crossing management for the use of the elderly (under hypothetical circumstances); and 6) socio-economic data of the respondents.

In this research, the regression model of Cameron (1988, pp. 355-379) was applied to analyze the willingness-to-pay for pedestrian crossings, particularly zebra crossing management. Double-bounded closed-ended questions were used to estimate the average expected willingness-to-pay [E(WTP)] as well as the factors affecting them, as described by equation (10) and details of the variables used are explained in Table No. 1.

$$(lower_i, upper_i) = a_0 + a_1 gender_j + a_2 age_j + a_3 edu_j + a_4 inc_j + a_5 incf_j + a_6 occ_{ij} + a_7 mema_j + a_8 crossdaily_j + a_9 crossfre_j + a_{10} safe_j + a_{11} freq_j + a_{12} acc_j + a_{13} use_j + a_{14} satis_j + a_{15} crossprob_j + a_{16} prob_j + a_{17} imp_j + a_{18} know_j + \mu_j / \text{distribution function} \quad \text{--- (10)}$$

Results

The results were divided into 3 parts: 1) general information; 2) behavior and opinions on the use of zebra crossings among the respondents; and 3) value of willingness-to-pay for the use of zebra crossings and the benefit of zebra crossings for the elderly.

1) General information

From interviews with the 437 respondents, it was found that most of them were female, aged 51 on average, had received elementary education, and earned average personal income of 15,616 baht per month. Most respondents had careers as entrepreneur/merchant. Their family, with 3

earning members, could generate an average income of 34,070 baht per month. There were 2 elderly people (aged 60 years and over) on average as family members.

Table No. 1 Variables and explanation

| Variable | Explanation |
|------------------|---|
| lower, upper | Lower and upper bound of willingness-to-pay of the respondent for zebra crossing management respectively |
| gender | Gender of respondent, where 0 = male and 1 = female |
| age | Age of respondent (years) |
| edu | Number of years of education of respondent (years) |
| inc | Average income of respondent (baht / year) |
| incf | Average family income of respondent (baht / year) |
| occ _i | Occupations of respondent, where i = 1, 2,..., 7 were private company employee, entrepreneur/merchant, government official/state enterprise employee/state officials, university student/college student, homemaker/housewife, self-employed, retired government official, respectively, and 0 = not engaging in such occupation and 1 = engaging in such occupation. However, the occupation of a private company employee was a reference variable. |
| mema | Number of elderly family members (persons) |
| crossdaily | Road crossing behavior in everyday life, where 0 = did not routinely practice and 1 = routinely practiced |
| crossfre | Most used method of crossing the road, where 0 = did not use a pedestrian crossing to cross the road and 1 = used a pedestrian crossing to cross the road |
| safe | Opinion on safety in using a pedestrian crossing in Bangkok today, where 0 = not safe and 1 = safe |
| freq | Frequency of using a zebra crossing to cross the road, where 0 = did not routinely use and 1 = frequently used. |
| acc | Pedestrian accident on zebra crossing, where 0 = never and 1 = ever |
| use | Opinion on whether the zebra crossing in Bangkok today is appropriate for use by the elderly, where 0 = not appropriate and 1= appropriate |
| satis | Satisfaction with current conditions of zebra crossings in Bangkok, where 0 = dissatisfied and 1 = satisfied |
| crossprob | Experiencing problems/obstacles in using zebra crossings in Bangkok, where 0 = had no experience and 1 = had experience |
| prob | Importance level of problems /obstacle in using zebra crossings in Bangkok of respondent (score) |



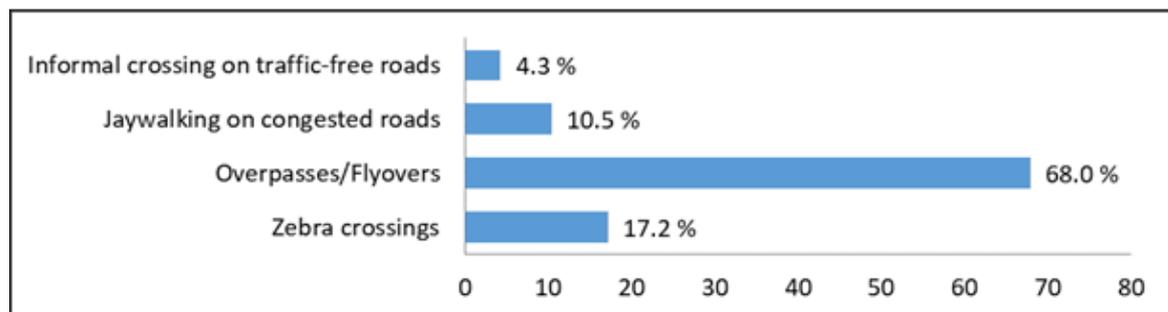
Table No. 1 (Continued)

| Variable | Explanation |
|---------------------------------|--|
| imp | Importance level of the role of zebra crossings in Bangkok, from viewpoint of respondent (score) |
| know | Knowledge and understanding about zebra crossings of respondent (score) |
| a_0 | Constant |
| a_k | Coefficient of the independent variable, where $k = 1, 2, \dots, 18$. |
| distribu- tion func- tion | Type of cumulative distribution function used in the analysis: log-normal distribution, log-logistic distribution, and Weibull distribution. The distribution model with the maximum value of the log-likelihood was used. |
| μ_j | Deviation |

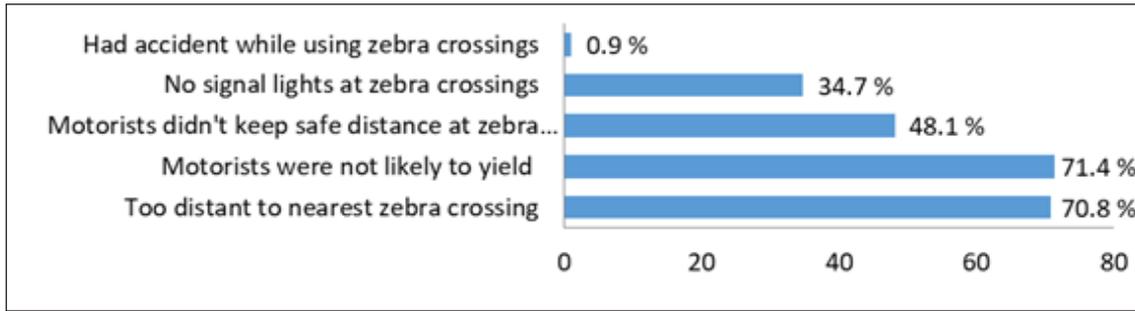
2) Behavior and opinions on use of zebra crossings among respondents

The largest group of respondents (55.20%) viewed a zebra crossing was a type of pedestrian crossing, that the BMA needed to improve, followed by pedestrian overpasses (34.30%) and pedestrian underpasses (10.50%). On the other hand, most respondents used pedestrian overpasses to cross roads (68%), followed by zebra crossings (17.2%), jaywalking conveniently on traffic congested roads (10.5%), and making informal crossings on traffic-free roads (4.3%), respectively (Picture No. 1).

In contrast to the 17.60 percent of respondents who did not use zebra crossings on a regular basis, 82.40 percent did not. Furthermore, 78.50 percent of the respondents who did not use zebra crossings to cross the road had various reasons. The most common reason was that motorists were not more likely to yield to pedestrians at zebra crossings, followed by zebra crossings were too distant to be practical for them to use, the motorists did not keep a safe enough distance at zebra crossings to ensure safety for pedestrians, no signal lights at zebra crossings, and they had experienced a road accident while using a zebra crossing, respectively (Picture No. 2).



Picture No. 1 Types of road crossing used by respondents



Picture No. 2 Reasons of respondents, who did not use zebra crossings to cross the road

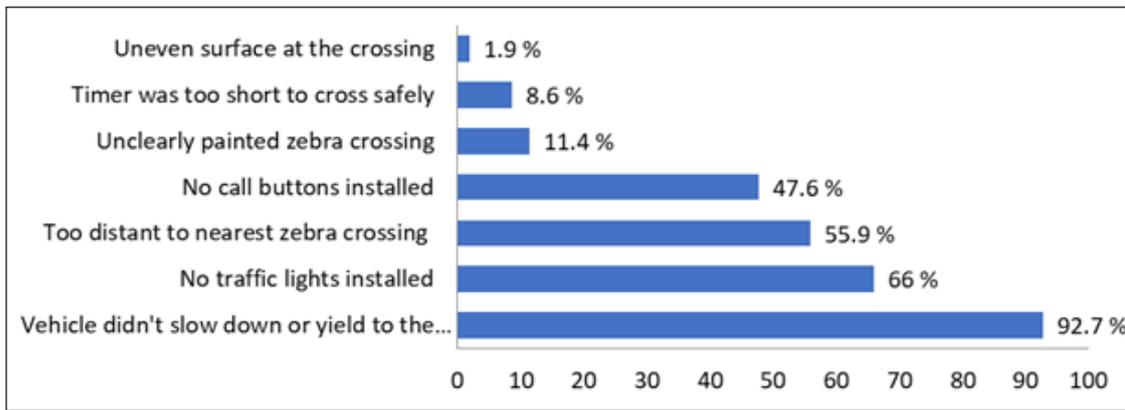
Of the respondents, 97.90 percent considered that the use of zebra crossings in Bangkok was unsafe. The given reasons were: motorists often did not slow down or yield to pedestrians (95.80%); there were no traffic lights at some zebra crossings (73.80%); and other reasons such as zebra crossings had unclear colors, and zebra crossings were located in close proximity to junctions with a free left turn lane (2.10%). Likewise, 85.10 percent of respondents thought that the zebra crossings in Bangkok were unsuitable for the elderly.

Many respondents (72.10%) had problems using zebra crossings. The most common problem was that vehicles did not slow down or yield to the pedestrian at the crossing, followed by: there were no signal lights at the crossings; distant zebra crossings required a long detour; there were no pedestrian call buttons installed at the crossings; the unclearly painted zebra crossings were difficult to find, especially at night; the pedestrian timer was too short to cross safely; and the road surface at the crossing was uneven, respectively (Picture No. 3).

The respondents attached importance to zebra crossings at the highest level (mean = 4.30). The first factor, determining the

importance level of the zebra crossing was awareness raising among motorists to slow down/yield to the pedestrians at zebra crossing (mean = 4.41). The following factors were: all pedestrians and motorists in the crossing area must strictly obey the traffic rules (mean = 4.38); zebra crossing management should be conducted to ensure the safety of all citizen groups (mean = 4.37); unless BMA can provide safe zebra crossing management; alternative types of crossings should be instituted for all citizen groups (mean = 4.19); and zebra crossings were a factor reflecting the quality of life of the people in Bangkok (mean = 4.13) (Table No. 2).

Referring to the correlation between type/method of crossing the road and the age of respondents (Table No. 3), it was found that respondents in different age groups used different types/methods to cross the road. There was a significant point that the proportion of elderly respondents and those aging (50-59 years) were less likely to use overpasses to cross the roads compared to respondents in other age groups. However, they were more likely to use zebra crossing, make informal crossings on traffic-free roads, or jaywalk on traffic-congested roads, respectively, compared to those in other age groups.



Picture No. 3 Problems in using zebra crossings in Bangkok

Table No. 2 Factors determining importance level of zebra crossings in Bangkok for respondents

Unit: person (percentage)

| Factors determining the importance level of the zebra crossing | Importance level | | | | | Total | Mean | Level | Rank |
|---|------------------|----------------|----------------------|----------------|----------------|-----------------|------|----------------|------|
| | Least important | Less important | Moderately important | Very important | Most important | | | | |
| Zebra crossing was a factor reflecting quality of life of the people in Bangkok | 9 (2.10) | 17 (3.90) | 52 (11.90) | 188 (43.00) | 171 (39.10) | 437 (100.00) | 4.13 | Very important | 5 |
| Zebra crossing management should be conducted to ensure safety of all citizen groups, including the general public, the elderly, and the disadvantaged. | 2 (0.50) | 1 (0.20) | 48 (11.00) | 167 (38.20) | 219 (50.10) | 437 (100.00) | 4.37 | Most important | 3 |

Table No. 2 (Continued)

| Factors determining the importance level of the zebra crossing | Importance level | | | | | Total | Mean | Level | Rank |
|---|------------------|----------------|----------------------|----------------|----------------|-----------------|------|----------------|------|
| | Least important | Less important | Moderately important | Very important | Most important | | | | |
| BMA has unsafe zebra crossing management; alternative types of crossing should be instituted for all citizen groups | 2 (0.50) | 12 (2.70) | 70 (16.00) | 171 (39.10) | 182 (41.70) | 437 (100.00) | 4.19 | Very important | 4 |
| Awareness raising among motorists to slow down/ yield to pedestrians at zebra crossing | 3 (0.70) | 6 (1.40) | 50 (11.40) | 130 (29.70) | 248 (56.80) | 437 (100.00) | 4.41 | Most important | 1 |
| All pedestrians and motorists in the crossing area must strictly obey the traffic rules | 5 (1.10) | 11 (2.50) | 45 (10.30) | 128 (29.30) | 248 (56.80) | 437 (100.00) | 4.38 | Most important | 2 |

Mean of importance level of zebra crossings in Bangkok = 4.30 (Most important)

| | |
|------------------------|------------------------|
| Remark:Least important | from 1.00 to 1.80 |
| Less important | more than 1.80 to 2.60 |
| Moderately important | more than 2.60 to 3.40 |
| Very important | more than 3.40 to 4.20 |
| Most important | more than 4.20 to 5.00 |



Table No. 3 Correlation analysis between type/method of crossing road and age of respondents

Unit: person (percentage)

| Most used type/ method of crossing the road | Age of respondents | | | | |
|---|--------------------|----------------|----------------|-----------------|----------------------|
| | 25-29 years | 30-39 years | 40-49 years | 50-59 years | 60 years and over |
| Zebra crossings | 6 (14.00) | 6 (14.00) | 5 (7.00) | 31 (22.00) | 27 (19.00) |
| Overpasses | 33 (77.00) | 36 (82.00) | 58 (84.00) | 89 (63.00) | 81 (58.00) |
| Jaywalking on traffic-free or congested roads | 4 (9.00) | 2 (4.00) | 6 (9.00) | 21 (15.00) | 32 (23.00) |
| Total | 43 (100.00) | 44 (100.00) | 69 (100.00) | 141 (100.00) | 140 (100.00) |

Chi-Square = 25.582 , d.f. = 8, Significance = 0.001

3) Value of willingness-to-pay for using zebra crossing and benefits for the elderly in Bangkok

The survey was conducted using hypothetical questions to identify the willingness-to-pay for zebra crossing management for appropriate use by the elderly in Bangkok. The majority of respondents (88.60%) agreed on zebra crossing renovation and a development project for the elderly, while only 11.40 percent disagreed. Among those agreeing, 56.80 percent were not willing to pay to support the project; and only 43.20 percent were willing to pay for the project. Among those disagreeing, 86.00 percent were willing to pay for the project, while of those who did not agree with the project, 14.00 percent were willing to pay to support the project.

On the whole, most respondents (60.20%) were not willing to pay to support the project; only 39.80 percent (174 respondents from the 437) were willing to pay. Furthermore, when it was proposed to these respondents that they pay a higher amount to improve the zebra crossings for appropriate use by the elderly, they were less likely to accept that increased initial amount. As an illustration, when it was proposed that the initial amount be 100 baht per person per year, 33.90 percent accepted this. However, when higher amounts, up to 200, 300, and 500 baht per person per year, were proposed, the percentage of the respondents, accepting the proposed amount, declined to 27.60 percent, 20.70 percent and 17.80 percent, respectively (Table No. 4).

Table No. 4 Number and percentage of respondents who accepted and rejected the initial amount (price) as an indicator of willingness-to-pay for zebra crossing management for appropriate use by the elderly in Bangkok

| Initial amount (Starting bid) (baht/person/year) | No. of respondents (persons) | Accepted | | Rejected | |
|--|------------------------------------|------------|---------------|------------|---------------|
| | | Number | % | Number | % |
| 100 | 110 | 59 | 33.90 | 51 | 19.40 |
| 200 | 109 | 48 | 27.60 | 61 | 23.20 |
| 300 | 109 | 36 | 20.70 | 73 | 27.80 |
| 500 | 109 | 31 | 17.80 | 78 | 29.70 |
| Total | 437 | 174 | 100.00 | 263 | 100.00 |

Where respondents accepted the initial price and then the secondary amount was double this, many were less inclined to accept the increase (cases of Yes-Yes) and were more likely to reject the increased secondary-amount (Yes-No cases). Where the respondents rejected the initial price, the interviewer halved the initial amount and proposed this as the second amount, the respondents were less inclined to accept the decreased amount (No-Yes cases) and were more even more inclined to reject an increased secondary amount (No-No cases). In summary, when the initial amount was increased, the tendency of respondents to accept the payment for zebra crossing renovation and development for the elderly reduced. If the initial amount was increased, the willingness-to-pay tended to decrease. In contrast, when the amount was halved, the willingness-to-pay increased (Table No. 5).

A log-normal distribution function maximizes the log-likelihood value and was used for the analysis of factors affecting

the willingness-to-pay for zebra crossing management for appropriate use by the elderly in Bangkok. It was found that the mean willingness-to-pay was 1,396 baht per person per year and its confidence interval was 556 - 2,226 baht per person per year (Table No. 6). When the mean willingness-to-pay was multiplied by the population of Bangkok (3,990,987 people) aged 25 and over in 2020 (Department of Provincial Administration, 2020), the total valuation of willingness-to-pay for zebra crossing management or the benefits received from zebra crossings for the elderly in Bangkok, in terms of value in 2020 was approximately 5,600 million baht per year.

At the 90 percent confidence level, the factors affecting the willingness-to-pay of respondents for zebra crossing management for appropriate use by the elderly in Bangkok were: the number of years of education (edu), the average income of respondents (inc), average family income (incf), and occupation of entrepreneur/merchant (occ2) (Table No. 7).



Table No. 5 Number and percentage of the respondents who accepted and rejected the secondary amount (price) to estimate willingness-to-pay for zebra crossing management for appropriate use by the elderly in Bangkok

| Initial amount (Starting bid) (baht/person/year) | No. of respondents (persons) | Expression of respondents (%) | | | | Total (%) |
|--|------------------------------------|-------------------------------|-------------|-------------|--------------|---------------|
| | | Yes-Yes | Yes-No | No-Yes | No-No | |
| 100 | 110 | 8.30 | 0.90 | 2.10 | 14.00 | 25.30 |
| 200 | 109 | 3.40 | 3.90 | 2.50 | 15.10 | 24.90 |
| 300 | 109 | 4.10 | 0.90 | 0.70 | 19.20 | 24.90 |
| 500 | 109 | 3.20 | 0.00 | 0.00 | 21.70 | 24.90 |
| Total | 437 | 19.00 | 5.70 | 5.30 | 70.00 | 100.00 |

Based on the results of the study, it was noticeable that the respondents with a higher number of years of education were less likely to willingly pay for the zebra crossing management for appropriate use by the elderly. This may have resulted from the respondents, receiving a higher education having a better understanding of the duties of the state, prescribed in the constitution. In particular, these provisions stipulate that the

state shall undertake or ensure that the basic utility services which are essential for the subsistence of the people are provided comprehensively following sustainable development. Thus, respondents with a higher education, presumably having a greater understanding of this state obligation would be less willing to pay for such services themselves.

Table No. 6 Value, mean willingness-to-pay, and confidence interval, based on log-normal cumulative distribution function

| | |
|---|-------------------|
| Log-likelihood value of equation (10) without independent variable | -140.92 |
| Log-likelihood value of equation (10) with independent variable | -121.04 |
| Intercept (β) | 6.45739 |
| Scale (σ) | 1.25240 |
| Pseudo R^2 | 0.1411 |
| Mean willingness-to-pay (Mean MWTP) ^{1/} (baht/person/year) | 1,396.38 |
| Confidence interval of mean willingness-to-pay ^{2/} (baht/person/year) | 556.01 - 2,226.75 |

Remark: ^{1/} Calculated from Mean WTP = $\exp^{(\beta + 0.5\sigma^2)}$

^{2/} Calculated from Mean WTP \pm 1.96 (SD of Mean WTP)

It was also found that the greater the average income of the respondents, the less tendency they had to willingly pay for zebra crossing management for appropriate use by the elderly in Bangkok. Just about all respondents (97.90 %) were of the opinion that the use of zebra crossings in Bangkok was unsafe. Therefore, when the respondents earned a higher income, they would have the ability to choose safer and more convenient travel choices, such as driving a private car, taking a taxi, and using the rapid rail transit. Traveling by such modes would lower their tendency to use zebra crossings and consequently would result in a lower level of importance being attached to zebra crossing development, as reflected by their reduced value for willingness-to-pay.

However, if the average family income of the respondents was higher, the tendency of the respondents to willingly pay for zebra crossing management for appropriate use by the elderly in Bangkok increased as well because the higher average family income was possibly caused by the larger number of members providing income in the family. Families with a larger number of members

were more likely to have elderly or aging members and this might result in such respondents attaching a higher level of importance to public utilities and services development. This importance was reflected through a stronger willingness-to-pay for zebra crossing management for appropriate use by the elderly in Bangkok by those with a higher average family income.

Compared with private company employees, respondents having occupations as an entrepreneur/merchant were less likely to be to pay for zebra crossing management for appropriate use by the elderly in Bangkok. The results showed that most respondents, working as entrepreneurs/merchants generally used private cars and motorcycles and they did not walk across roads in everyday life. In contrast, respondents working as private company employees were inclined to use public transport and had a higher chance of walking across roads. For this reason, the respondents working as entrepreneurs/merchants were less likely to attach importance to the development of appropriate zebra crossings than those, working as private company employees.

Table No. 7 Analysis of factors affecting willingness-to-pay value of respondents for zebra crossing management for appropriate use by the elderly in Bangkok

| Independent variables | Coefficient | P-Value |
|-----------------------|-------------|-------------|
| Intercept | 10.69013 | < 0.001 *** |
| gender | -0.07139 | 0.7973 |
| age | 0.01579 | 0.2474 |
| edu | -0.12929 | 0.0063*** |
| inc | -0.0000357 | 0.0955* |
| incf | 8.3851E-6 | 0.0478 ** |



Table No. 7 (Continued)

| Independent variables | Coefficient | P-Value |
|-----------------------|-------------|------------|
| occ2 | -1.37811 | 0.0107 *** |
| occ3 | -0.29880 | 0.4642 |
| occ4 | -0.91134 | 0.2026 |
| occ5 | -0.84819 | 0.3886 |
| occ6 | -0.28277 | 0.7077 |
| occ7 | 0.03260 | 0.9512 |
| mema | -0.0043457 | 0.9761 |
| crossdaily | 0.03414 | 0.9024 |
| crossfire | -0.28852 | 0.5159 |
| safe | 8.05415 | 0.9995 |
| freq | -0.19056 | 0.6923 |
| acc | -3.12634 | 0.6836 |
| use | -2.58525 | 0.7330 |
| satis | -2.65511 | 0.7277 |
| crossprob | -2.69901 | 0.7218 |
| prob | -3.56949 | 0.6407 |
| imp | 15.36263 | 0.6861 |
| know | -0.08488 | 0.2844 |

Log-likelihood ($\text{Ln}L_1$) = -121.04
Number of observations (N) = 437
Pseudo R^2 (%) = 14.11

Remark: *, **, *** indicate that the independent variables were statistically significant at confidence levels of 90, 95 and 99%, respectively.

Conclusion and Recommendations

This research applied the contingent valuation method to investigate the behavior and opinions toward the use of zebra crossings and to estimate the benefits obtained from zebra crossing management for appropriate use by the elderly. It was found that most respondents did not use zebra crossing to

cross the road but instead used an overpass. However, zebra crossings were the most demanded type of pedestrian crossing by the respondents. It was noticeable that elderly and aging respondents preferred a ground-level crossing to a different level of crossing. They also preferred immediately making informal crossings on the traffic-free roads or

jaywalking on traffic congested roads. These responses were consistent with the research by Anciaes and Jones (2018, pp. 222-237) that even though this crossing method was more likely to lead to road accidents than using an overpass, the elderly was not able to use the above ground level crossings because of the general deterioration or weakness of their physical condition, or chronic health conditions. The respondents also considered zebra crossings were not appropriate for use by the elderly as there were no traffic lights at the zebra crossings to stop vehicles and to allow pedestrians sufficient time to cross the road. This finding was consistent with the research of Laosirihongthong, Changjob and Charusirisombat (2013, pp. 9-12). Even so, the respondents attached importance to “public awareness” as the most important factor affecting the effective role of zebra crossings. Benefits, arising from the development of zebra crossings for the elderly would be primarily to society because other groups of people, such as the disabled, the disadvantaged, children and the general public could also efficiently make use of zebra crossings. This would improve the quality of life for people in the city in a sustainable manner. Therefore, this research makes the following recommendations.

1) “Raising public awareness” is the most important factor to make effective use of zebra crossings. To be precise, to reduce road accidents, motorists should yield to pedestrians at zebra crossings and allow them to cross the road at the zebra crossings. Family and school environments are the best places to foster public awareness by educating children or youth at a young age about road

safety as well as the traffic rules and social norms. This will reduce both the personal and social costs that may arise from a road accident.

2) As it was reported that many motorists did not slow down or yield to pedestrians to allow them to cross the road, the government agencies dealing with motorist behaviour management, such as the Traffic Police Division and the Department of Land Transport, should not only rigorously enforce taking legal measures and action against motorists who fail to obey traffic rules at crossings but also increase the associated penalties, especially for driving through a crossing without slowing down or failing to stop to yield to pedestrians waiting to cross the road.

3) The Bangkok Metropolitan Administration and other relevant agencies should be responsible for safe zebra crossing management, particularly by providing pedestrian signal lights or pedestrian call buttons at all zebra crossings, as well as building suitable curb ramps between the side walk and the road to facilitate access for the elderly at zebra crossings, in preparation for an aging society.

4) There should be renovation and development of safe and appropriate zebra crossings and ground-level pedestrian crossings to be used as replacements for overpasses. This would benefit the elderly and other groups, especially the disadvantaged including the disabled and people with chronic health conditions who may be physically incapable of using an overpass to cross the road.



5) Noteworthy and vibrant symbols should be installed to catch a motorist's attention to the zebra crossing. For example, zigzag road markings or a three-dimensional pedestrian crossing should be introduced to better alert motorists of the need to slow down and stop when approaching crossings where there are pedestrians waiting to cross the road, especially in areas where a lot of people regularly cross the road, such as at schools or fresh markets.

6) Based on the statistical analysis, the total value of willingness-to-pay for zebra crossing management for appropriate use by the elderly in Bangkok in 2020 was approximately 5,600 million baht per year. The value reflects the benefits that people would obtain from an actual zebra crossing management project. Safe zebra crossings, as an

appropriate public service, should be beneficial not only to the elderly but also to the general public, including children, the disabled, and the disadvantaged in society. As one of the findings showed, people agreed that zebra crossings are the first crossing type that needs to be improved. Government agencies should budget for the additional management of zebra crossings, including the installation of pedestrian signal lights or pedestrian call buttons at zebra crossings, painting traffic markings ahead of a zebra crossing to alert motorists, pavement surface renovation to draw the attention of motorists to slowing down and allowing pedestrians to use the crossing safely and to receive real benefits. This will make Bangkok a better livable city for all people.

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