A Study on Perception, Attitude and Willingness To Join a Volunteer Elderly Transport Support Program

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Transportation is a common daily challenge for many elderly people. Although numerous transport development and management solutions have been introduced to improve mobility and accessibility for senior citizens in Bangkok, Thailand, elderly volunteer transport support programs have rarely been considered. The first objective of this study was to investigate what types of volunteer services the elderly need to support their daily travel. Data collected from 134 elderly Bangkok residents indicated that 40% and 28% of them would like for the local government to establish volunteer carpool (VC) and volunteer public transport assistance (VPTA) services. Although volunteers are typically unpaid, fees per ride or per service would help to defray the costs of the volunteers without the volunteers making a personal profit. The study applied Kishi's logit price sensitivity measurement (Kishi's logit PSM, or KLP) approach to calculate the prices that the elderly would perceive as reasonable, which are 32.6 and 13.3 JPY per kilometer for VC and VPTA, respectively. The second objective was to estimate the number of Bangkok residents willing to volunteer and fulfill the requests of the elderly. The results from the binary logit model using data collected from 125 Bangkok residents indicated that the supply of volunteers could cover the demand for same-route services of both VC and VPTA even at the minimum service price. However, the price of VCs for different-route service should be subsidized by 4.3 JPY per kilometer to prevent it from being too expensive for the elderly.

Key Words : *binary logit model, carpooling, elderly, kishi's logit psm, public transport assistance, volunteer*

1. INTRODUCTION

The global population aged 60 years old and over will rapid increase from 11% in 2006 to 22% by 2050 [1)]. In the near future, the US will undergo significant growth in its population aged 65 and over, from 43.1 million in 2012 to an estimated 83.7 million in 2050 as a result of the large number of people born in the US during the Baby Boom between 1946 and 1964; this cohort started to turn 65 in 2011 [2)]. This phenomenon is occurring not only in the US but also in many other countries. With an increasing population of senior citizens, the governments in those countries should be prepared to support the needs of the elderly in the near future.

Transportation is a common daily challenge for the elderly due to their mental, physical, and financial conditions [3)]. To participate in community events, visit friends and relatives, perform administrative activities and attend medical appointments, the elderly need affordable, safe and convenient transportation that allows them to travel independently in their community [4)]. The availability of adequate transportation could support the mobility needs of elderly and prevent them from being isolated from society.

However, the sufficiency of transportation services depends on where the elderly live. The gov-

ernments of some countries have created strategies or programs to provide adequate transportation options for seniors. Although local authorities do not provide sufficient transportation choices, they would ideally offer assistance for finding alternative transportation for seniors.

In global south countries, such as Thailand, the proportion of the aging population will also see rapid increases from 16% in 2010 to 30% in 2035 [5]. However, the capital city of Bangkok has developed rapidly without making provisions for sufficient public transportation options that can support the travel needs of senior citizens [6]. Due to the physical conditions of Thai elderly, they tend to give up driving early and become more dependent on others or more socially excluded than those of earlier generations [7]. Elderly who are not satisfied with their mobility may be looking for independent transportation options to go out and participate in community activities.

The concept of utilizing the existing community resources, such as by establishing a volunteer transport support program, to provide Bangkok seniors with a complimentary transportation alternative, instead of constructing new infrastructure or transportation systems, has rarely been discussed. This program would encourage Bangkok residents, who generally drive their own cars or travel by public transit, to help seniors reach their destinations. Recently, ground transportation has become the major mode of transportation for most Bangkok residents. Therefore, two possible elderly support programs that were studied are 1) a volunteer carpool (VC) service, which refers to door-to-door service, picking up the elderly from one specific location and bringing them to another location with volunteer drivers who generally drive among community and non-profit organizations in Bangkok, and 2) a volunteer public transit assistance (VPTA) service, which refers to a program where volunteers provide the elderly with necessary support in their use of buses, vans and trains. This service would include providing training in using the transportation, providing travel information at the station and escorting the elderly resident to avoid dangerous situations that can arise when the elderly are by themselves, such as when getting on or off a vehicle.

It is important to know what types of volunteer services would best meet the needs of the elderly. Therefore, the objective of this study is to investigate what type of volunteer service the elderly need Bangkok's local government to provide for them. Volunteers in this system would not be paid and therefore would not make a personal profit. Although the local authority would establish the volunteer program, fees per ride or per service might be required to defray the costs of the volunteers. Thus, to set an appropriate price for the service, this study estimated acceptable prices based on the perceptions of the elderly by applying Kishi's logit price sensitivity measurement (Kishi's PSM, or KLP) method. In addition, the study estimated whether the potential supply of Bangkok residents willing to volunteer could cover the demands of the elderly by using binary logistic regression analysis. Finally, the proposed pricing strategy and implications are discussed.

2. LITERATURE REVIEW

(1) Transport Difficulty and Social Exclusion of the Elderly

Difficulty with transportation is a major factor leading to lower trip frequencies for many elderly, resulting in a decrease in their degree of community participation [7, 8]. It has been found that the reasons that the mobility of seniors is more limited than other age groups include their physical, financial and emotional conditions, such as poor walking ability and lack of income [9–11]. The elderly not only face challenges in their use of public transportation but also feel anxiety when driving; they subsequently become either more reliant on others or become more excluded from society [11]. In addition, the living conditions of some elderly discourage them from going out to join society. For example, many elderly are likely not only to be widowed but are also living in smaller families than earlier generations were, resulting in a lack of family members who can support them with their travel needs [12]. However, some previous studies have indicated that not every elderly person lacks mobility. Some seniors who have more free time and have saved more income than other groups make more trips than younger people, especially recreational trips [13, 14].

(2) Volunteer Transportation Support Program for the Elderly

In many communities, local authorities have established volunteer programs to support the mobility of the elderly. In global north countries, such as the US, Canada and Japan, governments have created programs to encourage volunteer Uber drivers to inquire about elderly residents who need door-to-door service to reach their destinations [15]. To support seniors, the cost per ride has often been subsidized by the government to the level at which it

is cheaper than a taxi ride [15]. Uber services have generated a higher confidence level with regards to travel; in contrast, taxi services suffer from uncertain quality, and some taxi drivers typically avoid servicing seniors [15].

In some cities such as in California, USA, some volunteer Uber drivers have joined an "Uber for seniors" program. They were training to be health care professionals and had sufficient knowledge of elderly psychology and ailments to support the elderly when needed [16]. In Japan, Uber's expansion in large cities such as Tokyo has been restricted by public transportation regulations. Nevertheless, the Japanese government has encouraged Uber drivers to service seniors living in rural areas where taxi and public transportation are not sufficient [17].

Although public transportation services are available in many communities, these services would ideally adapt to demographic changes and adjust to the needs of elderly passengers [18]. In some countries, when the use of public transport had been inconvenient for the elderly, local governments have developed public transport assistance programs, such as an "age-friendly public transport program" in Salzburg, Austria. This program aims to train the elderly with cooperative staff on how to conveniently use public transport, including how to get on and off safely and how to request a seat. Most elderly joining this training program found that it was very useful [19]. As another approach, the Ministry of Land, Infrastructure and Transport in Japan recently implemented the concepts of "barrier-free" and "universal design" to design usable public transport for every age group, particularly the elderly with limited mobility or mobility-impaired groups [20].

(3) Kishi's Logit PSM

The PSM method has been applied to evaluate customer perceptions when observing four product price levels, including "reasonable", "expensive", "too expensive to buy" and "too cheap to buy". KLP is a modified version of PSM developed to determine acceptable price ranges of customers, including ranges where a consumer feels the price is "reasonable", "neither expensive nor reasonable" and "expensive" [21]. The KLP method can be applied to set an appropriate price for any product or service.

KLP has been extensively applied to assess acceptable price ranges. For example, in 2002, the acceptable cost for snow removal for Japanese residences that varied with different levels of service was examined by Kishi et al. [22]. In 2003, Kishi and Satoh evaluated the acceptable cost of low-population vehicles in Sapporo and Tokyo in Japan; the result showed that the actual average price of low-population cars was higher than customer perceptions of a reasonable price [21]. Kishi and Satoh also applied KLP to examine the value of safety on the willingness of drivers to use the Doto expressway [23]; subsequently, Iwadate et al. used a similar method to find an acceptable toll price for this expressway in 2013 [24]. In 2015, The comparison of acceptable metro fares between Bangkok, Thailand and Manila, Philippines was studied by Baron and Choocharukul [25]. In addition, not only the price but also other types of scale values, such as an acceptable walking distance for access, can be analyzed by KLP. For example, in 2012, pedestrian access walking times and distance thresholds to urban metro stations were investigated by Yann et al. [26].

3. DATA AND ANALYSIS

(1) Survey Questionnaire

To collect the data for the present study, Bangkok was selected because this city has the largest population in Thailand. The survey was conducted in various areas of Bangkok in May 2017. The target respondents were divided into two groups as follows: 1) Bangkok elderly aged 60 and over who might need help from volunteers for transport and 2) Bangkok residents who could volunteer to respond to the needs of the elderly. Ultimately, 134 elderly residents and 125 other residents who were randomly selected were interviewed.

(2) The Needs of Elderly People

The questionnaire asked, "What type of volunteer transport support service do the elderly need the Bangkok government to provide for them to support their mobility?" Ninety-two of the 134 elderly Bangkok residents (68%) reported that they wished the local government to establish a volunteer carpool service (VC: 40%) and a volunteer public transit assistance service (VPTA: 28%) as shown in Figure 1. However, forty-two elderly residents (31%) did not require any service from volunteers. One reason may be that 24 of the elderly (18%) were from older groups (average 80.71 years old) than those who wanted to use VC and VPTA (average 65.11 and 67.47 years old), and this group tended to be in poorer health (impaired walking, vision and hearing abilities; 1.46 of 5), leading dependency on others who could take care of them while conducting their activities. When volunteers could support them only for transportation, these elderly preferred going out with their family or neighbors because those people

could not only take them to their destination but also take care them while they performed their activities at the destination. Another reason was that 18 of the elderly (14%) wanted local government to improve the convenience of taxi and public transportation services instead of relying on services from a volunteer.

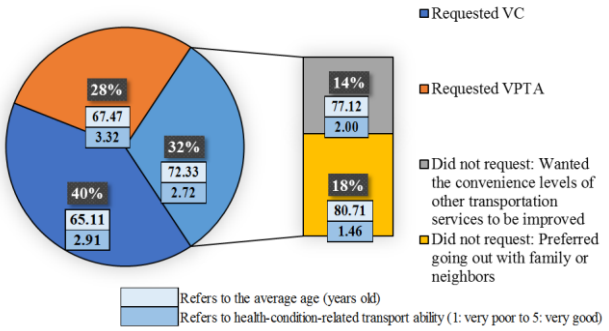


Fig.1 Volunteer service needs for the Bangkok elderly.

In addition, to investigate what reasons in terms of transport difficulty made the elderly request volunteer transport support services, the participants were asked to report their current daily transport situation, including their driving ability and their ability to use taxis and public transportation in Bangkok, as shown in Figure 2(*a*, *b* and *c*).

Figure 2(*a*) reveals that the driving skills of most of the elderly are considerably low, particularly for those who requested volunteer services because they were from older groups, as shown in Figure 1. Therefore, it seems that most elderly do not generally drive. Figure 2(*b*, *c*) indicates that most seniors who requested VC could not access either taxi or public transport services in their areas. Although some of them could use taxi and public transport services, these services were inconvenient for them. In these cases, VC could relieve deficits in their mobility. In addition, Figure 2(*b*, *c*) shows that all the seniors who prefer to use VPTA can already access public transit but that the convenience level of the service did not satisfy most of them, leading to requests for assistance.

(3) Requested Prices for Use of Volunteer Transport Support Services by the Elderly

This section investigates the price for acceptable service that the elderly can be expected to pay. To determine the perception of seniors to various service price levels, the KLP approach was applied. The elderly were asked to rate suitable prices for using the volunteer services, including:

1. Reasonable: the price at which they thought it was reasonable to use the service.
2. Expensive: the price at which they though it was expensive to use the service.
3. Too expensive to purchase: the maximum price they were willing to pay for using the service.
4. Too inexpensive to be willing to purchase: the minimum price below which they were not willing to use the service because they doubted the quality or safety of the volunteer service.

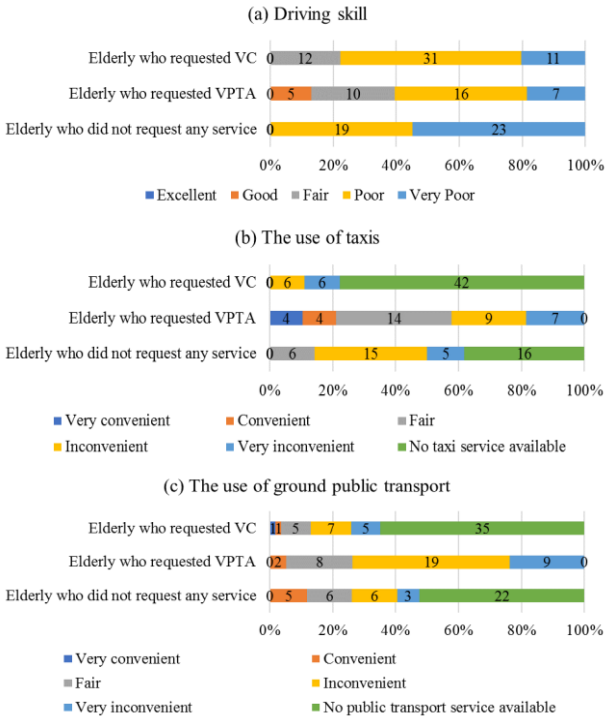


Fig.2 The current situation of daily transportation for elderly Bangkok residents.

In the traditional PSM approach, the four price levels reported by respondents would be used to generate cumulative frequencies as shown in Figure 3(*a*). The complementary "Reasonable" and "Expensive" frequencies are shown in Figure 3(*b*). Subsequently, to analyze the perception of customers, the cumulative frequency of "Reasonable" and "Expensive" is inverted into "Should be less expensive" and "Should be more expensive", as shown in Figure 3(*c*). However, acceptable price ranges could not be determined using only the PSM approach. By applying KLP, four relative cumulative frequencies were regressed using the continuous function of the binary logit model as shown in Equations (1) and (2). These functions were used to determine acceptable price ranges and standard prices, as shown in Figure 3(*d*).

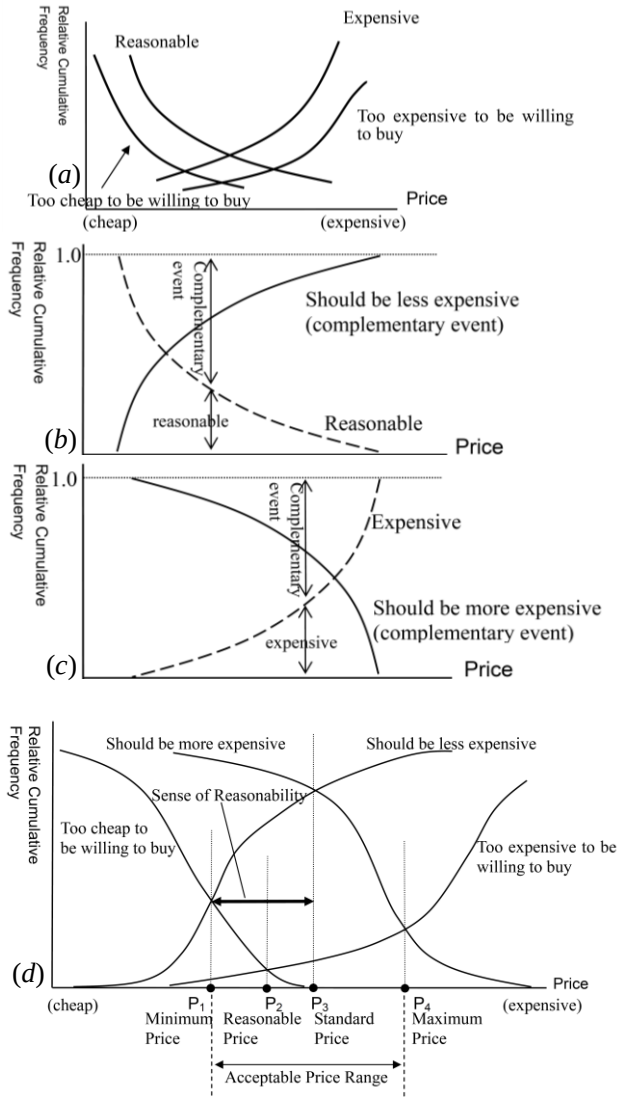


Fig.3 The price indicator references of PSM and KLP (*21*).

$$T_i(t) = \frac{1}{1+\exp(ax+b)} \quad (1)$$

$$F_i(x) = ax + b \quad (2)$$

where:

T_i : Relative cumulative frequency

$T_1; F_1$: Should be less expensive

$T_2; F_2$: Should be more expensive

$T_3; F_3$: Too expensive to be willing to use the volunteering service

$T_4; F_4$: Too cheap to be willing to use the volunteering service

x : Price of the volunteer service in Japanese Yen (JPY) per kilometer

a, b : Coefficients

The logit models of relative cumulative frequencies were determined based on Equations (3) to (11) and are plotted in Figure 4(*a*, *b*).

$$T = \frac{1}{1+\exp F(x)} \quad (3)$$

For VC:

$$T_1; F_1 = -0.155x + 4.501 \quad (R^2=0.98) \quad (4)$$

$$T_2; F_2 = 0.127x - 4.704 \quad (R^2=0.96) \quad (5)$$

$$T_3; F_3 = -0.092x + 4.639 \quad (R^2=0.96) \quad (6)$$

$$T_4; F_4 = 0.258x - 1.764 \quad (R^2=0.94) \quad (7)$$

For VPTA:

$$T_1; F_1 = -0.452x + 5.539 \quad (R^2=0.94) \quad (8)$$

$$T_2; F_2 = 0.379x - 5.545 \quad (R^2=0.97) \quad (9)$$

$$T_3; F_3 = -0.292x + 5.999 \quad (R^2=0.98) \quad (10)$$

$$T_4; F_4 = 0.753x - 0.998 \quad (R^2=0.99) \quad (11)$$

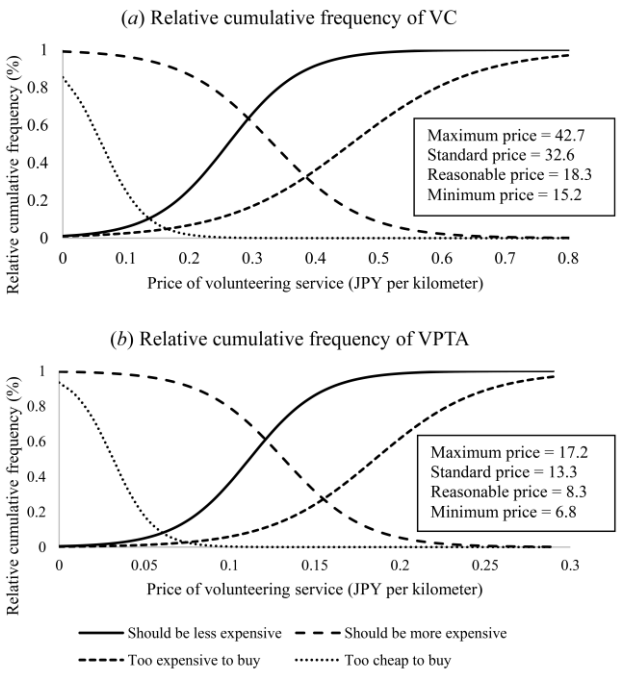


Fig.4 Price indicators for VC and VPTA analyzed by KLP.

Figure 4 shows that the maximum price of VC is 42.7 JPY per kilometer, which is higher than that of VPTA (17.2) because the elderly estimated that fuel costs and the costs of operating a vehicle by VC volunteers was more expensive than the fares for the public transport of VPTA volunteers. The minimum prices of both VC (15.2) and VPTA (6.8) referred to the prices at which the elderly doubted the quality or safety of the service by volunteers. Therefore, the market prices of VC and VPTA will be acceptable

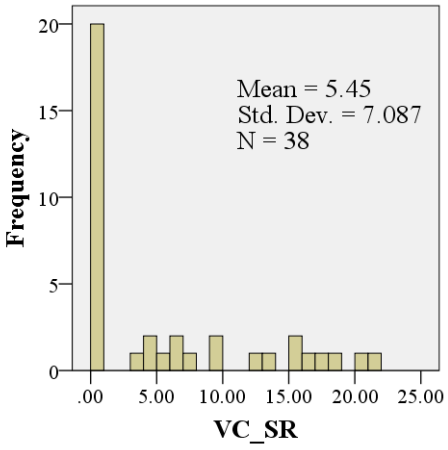
from 15.2 to 42.7 JPY and 6.8 to 17.2 JPY per kilometer. However, to make the elderly feel that the service prices are not expensive, the service price should be equal or less than the standard prices, which are 32.6 and 13.3 baht per kilometer for VC and VPTA, respectively.

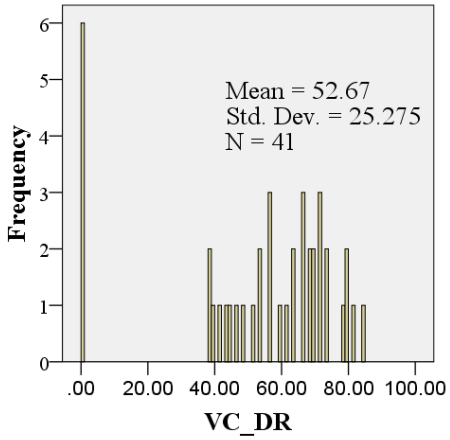
(4) The Amount of Supply for Volunteering Service

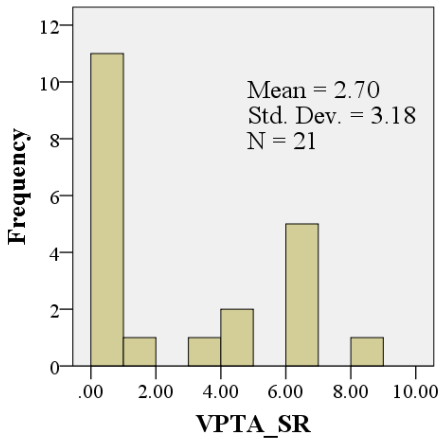
To investigate whether the amount of potential supply (Bangkok residents who were willing to volunteer) could cover the amount of demand (elderly needing the services of a volunteer), the questionnaire asked 125 residents if they were interested in volunteering to support the elderly in these programs as follows,

1. Volunteer carpool driver, same-route service (VC_SR)
2. Volunteer carpool driver, different-route service(VC_DR)
3. Volunteer public transport assistance, same-route service (VPTA_SR)
4. Volunteer public transport assistance, different-route service(VPTA_DR)

Same-route service refers to the case in which the volunteer provides service to the elderly along the same route that they generally commute or travel; different-route service refers to the case in which the volunteer assists seniors even along a different route than they commonly use. Subsequently, the potential volunteers were asked to state the amount of money they need to defray their costs of volunteering, such as fuel, transit fares and dedicated efforts, but not any profit. The frequency of volunteering categorized by acceptable price levels is plotted in Figure 5.







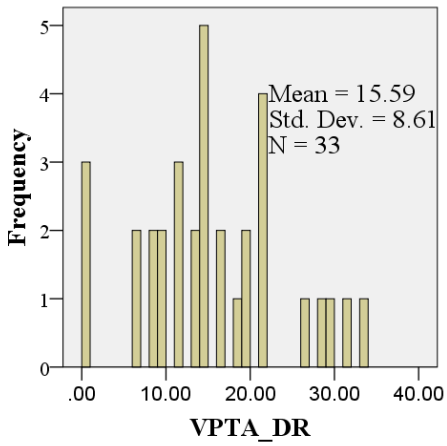


Fig.5 The histograms of the acceptable amount of supported money through volunteering in JPY per kilometer.

Figure 5 shows that 38 (30%), 41 (33%), 21 (17%) and 33 (26%) residents were interested in volunteering for VC_SR, VC_DR, VPTA_SR and VPTA_DR, respectively. Most people who were willing to service the elderly along the same route that they generally travel for both VC (20 people) and VPTA (11 people) were willing to volunteer without being paid because there were no extra travel costs for them. In contrast, those who would volunteer for different-route service tended to require

much more monetary support to operate their vehicle for VC and required extra transit fare for VPTA.

To estimate the potential demand, a binary regression analysis was developed to predict the supply. The outcome (independent variable: y) of the binary logit model was the decision of Bangkok residents to volunteer (1: yes or 0: no); the explanatory variables (x) were the price of the service in JPY per kilometer (S_PRICE), free time in hours per day during the week (FREE_T_WD) and on weekends (FREE_T_WE), anxiety levels in terms of their own safety while servicing unknown elderly, ranked from 1 (having no anxiety) to 5 (having complete anxiety) (ANXIE_LV), and the confidence level in their skills for providing elderly support ranked from 1 (completely unconfident) to 5 (completely confident) (CONFI_LV). Finally, four binary logit models for each kind of service were developed, as shown in Table 1.

Table 1 The binary logit model of Bangkok residents' willingness to volunteer

Variable	VC_SR	VC_DR	VPTA_SR	VPTA_DR
	Coef.	Coef.	Coef.	Coef.
S_PRICE	0.16*** (5.45)	0.09*** (52.67)	0.49*** (2.70)	0.34*** (15.59)
FREE_T_WD	(3.66)	1.05*** (3.39)	0.52* (3.90)	0.33* (4.03)
FREE_T_WE	(7.68)	(8.27)	(7.43)	0.45*** (7.24)
ANXIE_LV	-0.59*** (2.26)	-0.49** (2.46)	(1.62)	-0.87*** (1.94)
CONFI_LV	(3.11)	0.26* (3.15)	0.98*** (3.05)	0.72*** (3.00)
Constance	1.13	-7.77	-5.72	-10.51
Pseudo R^2	0.24	0.56	0.47	0.66

Note: ***, **, and * are 99%, 95%, and 90% significant, respectively; the number in the parenthesis () is the mean of each variable

Table 1 shows that S_PRICE has a positive significant relationship to the outcomes, which suggests that more residents would be willing to volunteer if they received additional financial support for volunteering. Free time during both weekdays (FREE_T_WD) and weekends (FREE_T_WE) has a significant positive relationship with the decision to volunteer, which implies that more residents would volunteer if they had more free time. However, free time has no significant relationship with VC_SR because volunteers for VC_SR would drive elderly residents only along the same route they generally traveled, which would not consume additional time as would different-route service.

In terms of the personality of residents, ANXIE_LV has a significant negative relationship with the outcomes. Some residents are concerned for their own safety while servicing unknown elderly. However, ANXIE_LV has no relationship with the decision to volunteer for VPTA_SR because the volunteer would support the elderly along their familiar route and in an open area (public transport station and vehicle); these conditions might make them feel less anxious than with other kinds of service. In addition, CONFI_LV has a positive relationship to the outcomes. It may be that the volunteers' confidence level in their elderly supporting skills affects their decision to volunteer for VC_DR, which would require adequate knowledge of travel routes in the community. VPTA (both VPTA_SR and VPTA_DR) would require a basic knowledge of how to support the elderly in the use of public transportation.

(5) The Supply-Demand Ratio

This section investigates whether or not the supply of volunteers can cover the demands of the elderly at an acceptable price based on the perception of demand, as analyzed by KLP and shown in Figure 4. The study estimated the supply-demand ratio (S/D) using Equations (12) to (14). If S/D is less than 1, the supply is inadequate to support demand, and vice versa. The simulations of S/D at each price indicator are shown in Table 2.

$$S/D = \frac{Q_{Supply}}{Q_{Demand}} \tag{12}$$

$$Q_{Supply} = \sum_{i=1}^{n} (PS_1 \times PS_2 \times P\_AGE_i \times POP\_AGE_i) \tag{13}$$

$$Q_{Demand} = \sum_{i=1}^{n} (PD \times P\_AGE_i \times POP\_AGE_i) \tag{14}$$

Table 2 Simulations of the Supply-Demand Ratio at Price Indicators Analyzed by KLP

Price indicator from KLP	Price	VC_SR		VC_DR	
		PS_2	S/D	PS_2	S/D
Maximum	42.7	99.87	9.83	29.52	1.44
Standard	32.6	99.35	9.78	14.79	0.72
Reasonable	18.3	93.88	9.25	4.74	0.23
Minimum	15.2	90.25	8.89	3.64	0.18
Optimum	36.9			20.48	1.00
Price indicator from KLP	**Price**	**VPTA_SR**		**VPTA_DR**	
		PS_2	S/D	%	S/D
Maximum	17.2	99.96	7.23	59.53	3.61
Standard	13.3	99.73	7.22	28.93	1.75
Reasonable	8.3	96.67	7.00	6.57	0.40
Minimum	6.8	93.16	6.74	4.00	0.24
Optimum	11.2			16.51	1.00

(6) Pricing and Implications

Table 2 indicates that more than enough residents are available to volunteer for VC_SR and VPTA_SR because the S/D values are much greater than 1. Although most people are willing to volunteer for same-route service without receiving payment from the elderly, the lowest price should be set at the minimum price (15.2 and 6.8 for VC_SR and VPTA_SR, respectively) where the elderly will not have doubts about the quality or safety of the service provided by the volunteer.

For the different-route service, the supply of VC_DR at the standard price (32.6) does not cover the demand. Therefore, the price should be set at the optimum price (36.9) that makes S/D equal to 1. However, the elderly will consider this optimum price is expensive because it is higher than the standard price according to Figure 3. In this case, the government can subsidize the service by 4.3 JPY per kilometer to make the perceived cost sufficiently affordable. In addition, the reasonable price of VPTA_DR (8.3) would not persuade sufficient residents to volunteer, but the optimum price of VPTA_DR (11.2) is already less than the standard price (13.3) and thus does not require a subsidy. Volunteering is unpaid by definition. Nevertheless, the elderly volunteer transport support program can be called "paid volunteering" because volunteers are paid to defray their extra travel costs.

The study also proposes additional suggestions for encouraging residents to volunteer. According to the results of Table 1, the government can encourage Bangkok residents who feel anxiety about their safety while servicing unknown elderly residents to volunteer for VC_DR by creating registration and database systems for volunteer services. Then, those volunteers can examine information regarding a registered elderly resident before providing services, which may increase the reliability of the system. Moreover, special workshops can be held to train those who are interested in volunteering but not sufficiently confident in their elderly support skills to participate in the VC and VPTA. An increased level of confidence in support skills can lead to higher chances of volunteering.

4. CONCLUSION

The aim of the study was to find solutions for improving the mobility of Bangkok elderly by proposing volunteer transport support services. The results indicate that most elderly living in an area without taxi and public transport services want the Bangkok government to create volunteering carpool (VC) service to drive them to their destinations. Furthermore, seniors with access to public transit but for whom the use of transit is inconvenient or difficult require assistance from volunteer public transport assistance (VPTA) service to support them when using public transit. However, some elderly who tend to be older and have poorer health do not want any support from these volunteer programs. These residents need to go out with family or neighbors who can not only get them to their destination but also take care of them while they are conducting activities. Some seniors would prefer that the local government improve the convenience level of Bangkok transportation services instead of requesting services from a volunteer.

KLP analysis was applied to determine an acceptable range of prices for services based on the perceptions of the elderly. From the price analysis, it was determined that the concept of a "paid volunteer" should be introduced because the elderly have doubts about the quality of the volunteer service when the price was too low and because many volunteers require compensation to defray their extra travel costs. The binary logit model showed the effects of a change in service price on the number of residents who were willing to volunteer to support travel needs. According to a simulation of the ratio of supply to demand (S/D), the potential supply of volunteers should cover the demands of the elderly for same-route service of both VC and VPTA even at the minimum price, whereas the demands of different-route service cannot be covered by the supply at this minimum price. The optimum price that made S/D equal to 1 for the different-route service of VPTA was already in the price range that the elderly did not feel was expensive. However, the price of VC for different-route service should be subsidized by 4.3 JPY per kilometer to make the elderly feel that the price is not expensive.

Alternatively, the Bangkok government can also encourage residents to volunteer by reducing the anxiety level of residents concerning their personal safety when they provide services to unknown elderly residents. Registration and database systems can be created to increase the reliability of the volunteer system, resulting in reduced anxiety levels. In addition, increasing confidence in elderly support skills by holding workshops to train residents and provide basic knowledge of how to support the elderly through VC and VPTA can persuade more residents to volunteer.

Policy makers can use these findings regarding pricing and other effects. The results for the supply-demand ratio are limited by their reliance on only

the origin and destination (O-D) of the collected samples. The same procedures can be replicated with the total O-D data of Bangkok residents that can be obtained using the extended Bangkok Transport Model (eBUM) [27]. In addition, this study analyzed only the price structure in JPY per kilometer, but other price structures should be studied, such as considering fixed pricing in the pricing analysis.

APPENDIX

Where:

S/D: Supply-demand ratio

Q_{Supply}: Total supply (people)

Q_{Demand}: Total demand (people)

PS_1: The proportion of Bangkok residents who are interested in volunteering, obtained from Figure 5 as follows:

VC_SR (30%), VC_DR (33%), VPTA_SR (37%) and VPTA_DR (26%)

PS_2: The proportion of residents who are willing to volunteer, determined by the binary logit model in Table 1 when the service price is varied; the average values of other factors were substituted into the model

PD: The proportion of elderly requesting volunteer services as follows:

- Elderly travelling in the same route as the supply would be categorized into VC_SR (13%) and VPTA_SR (10%).
- Elderly travelling along a different route than the supply would be categorized into VC_DR (28%) and VPTA_DR (18%).

P_AGE_i: The proportion of the number of samples in each age range (years) as follows:

- Supply: 24% (20 to 29), 28% (30 to 39), 26% (40 to 49), and 22% (50 to 59)
- Demand: 32% (60 to 64), 24% (65 to 69), 21% (70 to 74), 13% (75 to 79), 8% (80 to 84), and 3% (85 to 90)

POP_AGE_i: Total number of Bangkok population in each age range (years) according to national statistic at the early of 2017 [28] as follow,

- Supply: 766,916 (20 to 29), 863,105 (30 to 39), 910,039 (40 to 49), and 831,752 (50 to 59)
- Demand: 310,847 (60 to 64), 233,715 (65 to 69), 148,590 (70 to 74), 112,379 (75 to 79), 74,443 (80 to 84), and 37,163 (85 to 90)

REFERENCES

1) World Health Organization. : *WHO Library Cataloguing-in-Publication Data*. Geneva, 2007.
2) Ortman, J. M., Velkoff, V. A. and Hogan, H. : *An Aging Nation: The Older Population in the United States*. Census Bureau, U.S., 2014.
3) Publishing, D. K. : *Caregiver's Handbook*. DK, New York, 2013.
4) Connolly, J. : Finding Transportation Services for Seniors. https://www.agingcare.com/articles/finding-transportation-services-for-seniors-104572.htm. Accessed May 17, 2017.
5) Knodel, J., Teerawichitchainan, B., Prachuabmoh, V. and Pothisiri, W. : *The Situation of Thailand's Older Population*. Social Research, University of Michigan, 2015.
6) Suparb, T. and Ranjith, P. : Environmental Assessment for Small- and Medium-Scale Road Projects Implemented in Local Authority Areas: A Case Study from Thailand. *Journal of Construction in Developing Countries*, Vol. 14, 2009, pp. 55–76.
7) Tansawat, T., Kishi, K., Choocharukul, K. and Kanitpong, K. : Unsatisfactory Transportation and Its Effects in Social Exclusion: The Case of the Elderly in a Developing Country. Presented at the 96th Annual Meeting Transportation Research Board, 2017.
8) Currie, G. and Delbosc, A. : Modelling the Social and Psychological Impacts of Transport Disadvantage. *Transportation*, Vol. 37, No. 6, pp. 953–966, 2010.
9) Kneale, D. : *Is Social Exclusion Still Important for Older People?* The International Longevity Centre - UK (ILC-UK), UK, 2012.
10) Schwanen, T., Banister, D. and Bowling, A. : Independence and Mobility in Later Life. *Geoforum*, Vol. 43, No. 6, pp. 1313–1322, 2012.
11) Jansuwan, S., Christensen, K. M. and Chen, A. : Assessing the Transportation Needs of Low-Mobility Individuals: Case Study of a Small Urban Community in Utah. *Journal of Urban Planning and Development*, Vol. 139, No. 2, pp. 104–114, 2013.
12) Endicott, J., Nee, J., Harrison, W. and Blumenthal, R. Endicott J, Nee J, Harrison W, Blumenthal R. : Quality of Life Enjoyment and Satisfaction Questionnaire: A New Measure. Psychopharmacol Bull 29: 321-326. *Psychopharmacology bulletin*, Vol. 29, No. 2, pp. 321–6, 1993.

13) Leitner, M. J. and Leitner, S. F. : *Leisure in Later Life*. Sagamore Publishing LLC.
14) Hahn, J. S., Kim, H. C., Kim, J.-K. and Ulfarsson, G. F. : Trip Making of Older Adults in Seoul: Differences in Effects of Personal and Household Characteristics by Age Group and Trip Purpose. *Journal of Transport Geography*, Vol. 57, pp. 55–62, 2016.
15) Campbell, H. : Why Senior Citizens Are Flocking to Uber. TaxiFareFinder Newsroom, Oct 06, 2015.
16) Schiller, B. : This Ride-Sharing Service Is Like Uber for the Elderly. *Fast Company*. https://www.fastcompany.com/3035804/this-ride-sharing-service-is-like-uber-for-the-elderly. Accessed May 17, 2017.
17) Demetriou, D. : Uber Targets Elderly Passengers in Rural Japan. *The Telegraph*, 2016.
18) Schinagl, S. and Gasteiner, A. : *Serving Older Passengers: Training Manual for Bus Drivers*. 2010.
19) Gasteiner, A. : http://www.cor.europa.eu/en/events/forums/Documents/gasteiner.pdf. Accessed May 17, 2017.
20) Akiyama, T. and Kim, J. : Transportation Policies for the Elderly and Disabled in Japan. *International Journal of Urban Sciences*, Vol. 9, No. 2, pp. 87–98, 2005.
21) Kishi, K., and Sato, K. : Evaluation of Willingness to Buy a Low-Pollution Car in Japan. *Journal of the Eastern Asia Society for Transportation Studies*, Vol. 6, pp. 3121–3134, 2005.
22) Kishi, K., Takahashi, Y., Hara, F. and Satoh, K. : Level of Snow Removal Service and Residents' Willingness to Pay: Evaluation for Four Japanese Cities. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 1794, pp. 72–76, 2002.
23) Kishi, K. and Sata, K. : Drivers' Mental Burden Reduction Effects of the Opening the Expressway in Mountainous Area. In *12th WCTR*, No. 12, Lisbon, Portugal, 2010.
24) Iwadate, K., Nakatsuji, T. and Kishi, K. : Evaluation of Toll on Doto Expressway by Considering Value of Safety. *Proceedings of the Eastern Asia Society for Transportation Studies*, Vol. 9.
25) Baron, M. K. and Choocharukul, K. : Travel Behavior and Responses to Change in Transit Fare: A Comparative Study of Urban Rail Passengers between Bangkok and Manila. *Journal of the Eastern Asia Society for Transportation Studies*, Vol. 11, pp. 1188–1200, 2015. https://doi.org/10.11175/easts.11.1188.
26) Yang, R., Yan, H., Xiong, W. and Liu, T. : The Study of Pedestrian Accessibility to Rail Transit Stations Based on KLP Model. *Procedia - Social and Behavioral Sciences*, Vol. 96, pp. 714–722, 2013.
27) *The Final Report TDL*. Office of Transport and Traffic Policy and Planning, 2015.
28) Official Statistics Registration Systems. http://stat.dopa.go.th/stat/statnew/upstat_age_disp.php. Accessed Jul. 19, 2017.

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