VALUE OF TIME AND SERVICE QUALITY FOR BUS TRAVEL IN BANGKOK: VALUATION AND POLICY IMPLICATIONS

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1. INTRODUCTION

The valuation of savings on travel time has long been an important issue in transport planning and policy formulation. For several decades, the valuation of savings on travel time has been an important tool for social appraisal of public investment (Jara-Diaz, 2000). For example, in the United Kingdom the Department of Transport in 1980 commissioned a major study on the value of savings on travel time (MVA et al., 1987). In 2000, another study of the value of such time also addressed aspects of service quality, such as the value of walking time, wait time and service headway (time interval between buses, trains etc.) associated with public transport use (Mackie et al., 2003). Those values were derived from a meta-analysis using a large data set of empirical evidence from the United Kingdom (Wardman, 2001, 2004; Shires and de Jong, 2009).

The value of time is a key parameter for creation of a transport model, particularly the modal split model of the four-stage model. The specific role of the value of time is to represent the trade-off between cost and time in the travel budget, which indicates how much people are willing to pay for saving travel time in the trips they make. Furthermore, the value of time is also used to calculate the economic benefit of transport improvement projects. For example, for major road schemes savings on travel time form the most significant benefit, which may account for about 80 percent of the monetized benefits within a cost-benefit analysis (Mackie et al., 2001). Traveling by public transport involves walking and waiting for such services. Walk and wait times can be expected to be crucial values, which may be much greater than in-vehicle travel time (IVT). This is because there are fewer opportunities for making productive use of time, and such travel may be undertaken in a less pleasant environment than in a vehicle (Wardman, 2004).

Walk and wait times were believed to be valued, on average, at twice or more than the in-vehicle

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travel time. However, in a review of evidence from a number of developed countries, the Steer Davies Gleave consultancy (1997) concluded that walking time is usually valued at between 1.8 and 2.4 times that of IVT (an average of 2.0 is recommended), and that waiting time is valued at up to 4.5 times higher than walking time (a ratio of 3 times is recommended). With regard to a review of British stated preference evidence, Wardman (2001) found that the values of walk, wait and headway were, on average, valued at 1.66, 1.47 and 0.80 times IVT, respectively. More recent results reviewed by Wardman (2004) concluded that the values of walk and wait times, erroneously influenced by stated preference evidence, were too low. It is recommended that it is reasonable to value walk time at twice IVT, and to give a weight of 2.5 for wait time. In addition, walk and wait time values can be expected to vary according to a wide range of socio-economic and situational factors.

In developing countries, a number of research studies have been conducted on the values of travel time, but there remains a lack of research on other service valuations. The ratio of twice the value of IVT for walk time may be used as a basic ratio; however, it is not clear whether this rule of thumb applies in developing countries. Further research is thus required in such countries.

This article therefore contains a report on the research conducted in Bangkok for estimating the values of time and bus service qualities, including waiting time, transfers, and level of crowding on buses. First, a review of studies on the values of time in Bangkok is presented in Section 2. The study method and data collection, which concerned bus users' attitudes and behavior based on a stated preference technique, is presented in Section 3. The behavior model of bus users responding to service improvements is analyzed and discussed in Section 4. Finally, Section 5 contains the conclusion and policy recommendations.

2. REVIEW OF VALUES OF TRAVEL TIME IN BANGKOK

The value of time is an essential parameter in the transport model. For this reason, in one of the early studies of the transport model in Bangkok, the values of travel time were estimated based on the rate of income. In the Urban Transport Database and Model Development project (OCMLT, 1998), the values were based on 25 percent of the average household hourly income in 1995. Values differed according to household vehicle ownership. The average value of time was 0.80 baht per minute, which was equivalent to about US$0.032 in 1995. Households with no vehicle had the lowest value of time (0.44 baht per minute), while households with multiple vehicles had the highest value (1.30 baht per minute).

Later, a few studies were undertaken on the values of travel time in Bangkok. The following selected results are based on revealed preference and stated preference surveys. During the period 2001-2005, under the two projects, Transportation Data and Model Center (TDMC) II and III (OTP, 2004; 2005), the values of travel time for different modes of travel were estimated based on revealed preference data. The values of time varied among different travel modes and trip purposes. The highest value was 0.85 baht per minute for a work trip involving car use. The lowest value was 0.27 baht per minute for a non-work trip in low-comfort public transport, such as non air-conditioned bus or boat.

During 2006/07, the Bangkok Metropolitan Authority studied the feasibility of a bus rapid transit (BRT) project (Krungthep Thanakom, 2007). It was found that the value of travel time saving using BRT was 1.20 baht per minute. This estimation was based on stated preference data and mode choice multinomial logit model.

The most recent study (in 2010) was focused on the development of a fare structure for public transport and integrated systems (OTP, 2010). The values of travel time for different modes of travel were estimated, based on stated preference data. The highest value of time was 2.01 baht per minute for car use, while the lowest value, 0.80 baht per minute, was for use of a non-air-conditioned bus.

Obviously, the values of travel time varied across the studies. They show that the values of travel time

were different among various socio-economic groups and modes of travel. The variation was also likely to be because: (a) the estimation methods were different; (b) the values increased over time (due increases in income and level of congestion/crowding); and (c) the stated preference experiments were different in terms of the purposes of the studies, the choices offered, the attributes included and their levels. There has been considerable debate concerning the influence of the choice of method on the values of time (see, for example, Brownstone and Small, 2002; Wardman, 2004).

For other service components of public transport use, such as wait time, walk time and interchange/transfers, no such study has been conducted in Thailand. To the best of the authors' knowledge, the values of public transport service quality are also not well researched in other developing countries. The ratio of twice the value of IVT for walk and wait times may be used as a rule of thumb; however, there is no evidence whether this would apply in such developing countries.

3. METHODOLOGY

A stated preference technique was used to examine the values of bus travel time and other services in Bangkok. The data collection and modeling issues are explained as follows.

3.1 Data collection and sample characteristics

The main data collection was conducted by interviewing bus users during February and March 2009. The responses obtained did not indicate any problems with the stated preference exercise. The data set available for modeling purposes enabled removal of those who had not fully completed the questions. Total sample size was 1,632 individuals.

The survey revealed that the average travel time by bus from point of origin to destination in Bangkok was 65.7 minutes, which included average access time of 7.5 minutes (11%), wait time of 12.6 minutes (19%), in-vehicle travel time of 39.0 minutes (59%), and egress time of 6.1 minutes (9%).

The stated preference survey was used to study choice behavior. Individuals were asked to choose between non-air-conditioned and air-conditioned buses. The stated preference exercises contained five attributes: bus fare; in-vehicle travel time; wait time; number of interchanges; and level of crowding on the bus. The fare was in the unit of money; in-vehicle travel time and wait time were in the unit of minutes. Three levels of the number of interchanges were 0, 1, and 2. Three levels of crowding on the bus were “low,” “medium” and “high.”

If all attributes had been presented in one exercise, respondents might have ignored some attributes because there were too many variables to consider. To overcome this problem, separate designs were used. Three stated preference exercises were designed, and each exercise contained three attributes: two basic attributes, namely that were the fare and the in-vehicle travel time, plus the third attribute (wait time for Exercise 1, number of interchanges for Exercise 2, and level of crowding on the bus for Exercise 3). For each stated preference exercise, a fractional factorial design was used for selecting a subset of the full factorial design. In total, each respondent was presented with nine service scenarios.

3.2 Modeling issues

The most straightforward means of analyzing discrete choice is to calibrate a multinomial logit (MNL) model (standard model), which can demonstrate the overall effects for the whole sample. Then the segmentation analysis can be applied to examine the effects of personal characteristics.

The standard MNL model is a common analysis method for explaining choice behavior, based on the random utility theory (Domencich and McFadden, 1975). This model expresses the probability (P) that an individual i chooses some alternative j as a function of the utilities (V) of the M alternatives in the choice set, as defined in Equation 1.

$$P_{ij} = \frac{e^{V_{ij}}}{\sum_{m=1}^{M} e^{V_{im}}} \qquad (1)$$

The utility (V) for any alternative j is related to relevant attributes (X_j) representing the alternative and individual situation, e.g. time and cost, which is defined as $V_{ij} = \sum_{k=1}^{K} \beta_{jk} X_{ijk}$. The estimation process of utility parameters (β_{jk}) is widely based on the maximum likelihood estimation. The utility parameters (β_{jk}) can be interpreted as an estimate of the weight of attribute k in the utility function V_j of alternative j.

Segmentation techniques are used to explore differences between the personal characteristics of respondents. This can be done by using incremental factors that allow different marginal utilities across segments of the sample (MVA et al., 1987). The factors can be specified as $\sum_{y=1}^{n-1} \gamma_y \, d_{ky} \, X_{ijk}$, where γ_y is an incremental factor for the k^{th} attribute (X_k) and d_{ky} is a dummy variable denoting whether an observation is in the y^{th} group of n groups in a category. If so, d_{ky} is equal to one; otherwise, zero. One of the groups in the category is chosen as a base. The incremental effects for other groups are relative to this base, so only n-1 dummy variables are defined. The utility function of the alternative j is expressed as $V_{ij} = \Sigma_k \beta_{jk} X_{ijk} + \sum_{y=1}^{n-1} \gamma_y \, d_{ky} \, X_{ijk}$. Thus, in Equation 3, the coefficient of the base group would be β_{jk}, and the coefficient of X_{jk} for the y^{th} group in the category would be $\beta_{jk} + \gamma_y$. This approach indicates the sign and size of any effect from the segmentation variable, and provides its statistical significance.

4. BEHAVIOR MODEL OF BUS USERS RESPONDING TO SERVICE IMPROVEMENTS

4.1 The model and result

In the stated preference survey (Section 3.1), individuals were asked to choose between non-air-conditioned and air-conditioned buses. The utility function of each service is shown in Equation 2.

$$\left.\begin{aligned} \text{U\_old service} &= \beta f\,(\text{Fare}) + \beta t\,(\text{Travel time}) + \beta w\,(\text{Wait time}) \\ &\quad + \beta i1\,(\text{Interchange 1}) + \beta i2\,(\text{Interchange 2}) \\ &\quad + \beta c1\,(\text{Crowd 1}) + + \beta c1\,(\text{Crowd 2}) \\ \text{U\_new service} &= \text{ASC} + \beta f\,(\text{Fare}) + \beta t\,(\text{Travel time}) + \beta w\,(\text{Wait time}) \\ &\quad + \beta i1\,(\text{Interchange 1}) + \beta i2\,(\text{Interchange 2}) \\ &\quad + \beta c1\,(\text{Crowd 1}) + + \beta c1\,(\text{Crowd 2}) \end{aligned}\right\} \quad (2)$$

in which

U_old service	:	Utility of non-air-conditioned bus
U_new service	:	Utility of air-conditioned bus
ASC	:	Alternative specific constant
Fare	:	Bus fare
Travel time	:	In-vehicle travel time
Wait time	:	Waiting time at bus stop
Interchange 1	:	Dummy variable for one interchange (traveling with one interchange, "Interchange 1" = 1, and traveling without interchange, "Interchange 1" = 0)
Interchange 2	:	Dummy variable for two interchanges (traveling with two interchanges, "Interchange 2" = 1, and traveling without interchange, "Interchange 2" = 0)
Crowd 1	:	Dummy variable for "Medium" crowded bus (traveling on the "Medium" crowded bus, "Crowd 1" = 1, and traveling on the "Low" crowded bus, "Crowd 1"= 0)
Crowd 2	:	Dummy variable for "High" crowded bus (traveling on the "High" crowded bus, "Crowd 2" = 1, and traveling on the "Low" crowded bus, "Crowd 2"= 0)
β	:	Coefficients of the variables

The data were analyzed using the standard logit model and segmentation model (Section 3.2). The alternative specific constant (ASC) for a new service allows for any preference for the air-conditioned bus over the other type, all other things being equal.

For the basic model (without including the effects of personal characteristics), coefficients and their t-ratios are reported in Table 1. Tables 2-4 contain the results of the models, segmented by trip purposes, household vehicle ownership, and total travel time, respectively. The overall ρ^2 goodness of fit was satisfactory, with the figure of about 0.1 that stated preference models typically achieve in conventional travel choice contexts.

The results show that ASC has a positive sign, indicating that in general the new service is significantly more preferable than the existing bus service, when everything else is equal. All other variables have significant negative effects in the utility function, as expected, indicating that the utility would fall if the level of variables increases.

Table 1. Coefficients of the variables for the standard logit model

Variables	Coefficient	t-ratio
Alternative specific constant	0.2544	4.3
Fare (βf)	-0.0495	-11.4
Travel time (βt)	-0.0629	-17.1
Waiting time (βw)	-0.0722	-9.0
Interchange 1 (βi1)	-1.3519	-18.8
Interchange 2 (βi2)	-2.2198	-24.4
Crowd 1 (βc1)	-0.3725	-4.7
Crowd 2 (βc1)	-1.0371	-16.0
No. of observations	14,688	
ρ^2 with respect to constants	0.0952	

However, different groups of people evaluate systems and attributes differently. We explored the extent to which results differed according to personal characteristics by using the segmentation model. The effects of some variables examined, including sex, age of respondent and household income, were not significant (at the 95% Confidence Interval). Some variables, including trip purposes, household vehicle ownership, and total travel time, significantly affected the choice. Incremental factors, representing the differences among the segments, were applied to the model in Tables 2-4.

Table 2. Coefficients of the variables for the logit model segmented by trip purposes

Variables	Coefficient	t-ratio
Alternative specific constant	0.2652	4.5
Fare (βf)	-0.0499	-11.4
Travel time-based (βt) group – Home-based work (HBW)	-0.0568	-10.9
Incremental factor		
+ Home-based school (HBS)	-0.0261	-5.0
+ Home-based others (HBO)	0.0065	1.3
+ Non-home-based (NHB)	-0.0150	-2.0
Waiting time-based (βw) group – Home-based work	-0.0543	-3.3
Incremental factor		
+ Home-based school (HBS)	-0.0439	-2.1
+ Home-based others (HBO)	0.0019	0.1
+ Non-home-based (NHB)	-0.0752	-2.6
Interchange 1 (βi1)	-1.3437	-18.7
Interchange 2 (βi2)	-2.2055	-24.2
Crowd 1 (βc1)	-0.3781	-4.8
Crowd 2 (βc1)	-1.0285	-15.8
No. of observations	14,688	
ρ^2 with respect to constants	0.0990	

Table 3. Coefficients of the variables for the logit model segmented by household vehicle ownership

Variables	Coefficient	t-ratio
Alternative specific constant	0.2767	4.6
Fare (βf)	-0.0532	-11.7
Travel time-based (βt) group – households without vehicle	-0.0371	-8.6
Incremental factor		
+ Households with one car	-0.0442	-9.3
+ Households with more than one car	-0.0738	-11.9
Waiting time-based (βw) group – households without vehicle	-0.0408	-3.7
Incremental factor		
+ Households with one car	-0.0604	-3.6
+ Households with more than one car	-0.0672	-3.1
Interchange 1-based (βi1) group – households without vehicle	-1.3208	-13.3
Incremental factor		
+ Households with one car	-0.0671	-0.5
+ Households with more than one car	-0.3969	-2.2
Interchange 2-based (βi2) group – households without vehicle	-1.9982	-15.3
Incremental factor		
+ Households with one car	-0.2985	-1.5
+ Households with more than one car	-0.9478	-3.9
Crowd 1-based (βc1) group – households without vehicle	-0.2805	-2.5
Incremental factor		
+ Households with one car	-0.1263	-0.7
+ Households with more than one car	-0.3079	-1.3
Crowd 2-based (βc1) group – households without vehicle	-0.7099	-8.2
Incremental factor		
+ Households with one car	-0.4365	-3.5
+ Households with more than one car	-0.9063	-5.6
No. of observations	14,688	
ρ^2 with respect to constants	0.1135	

Table 4. Coefficients of the variables for the logit model segmented by total travel time

Variables	Coefficient	t-ratio
Alternative specific constant	0.2520	4.3
Fare (βf)	-0.0504	-11.5
Travel time-based (βt) group – total travel time less than 60 minutes	-0.0560	-14.6
Incremental factor		
+ Total travel time of 60 minutes or more	-0.0308	-6.5
Waiting time (βw)	-0.0731	-9.0
Interchange 1-based (βi1) group – total travel time less than 60 minutes	-1.1692	-15.1
Incremental factor		
+ Total travel time of 60 minutes or more	-0.9262	-5.5
Interchange 2-based (βi2) group – total travel time less than 60 minutes	-2.0297	-20.1
Incremental factor		
+ Total travel time of 60 minutes or more	-0.9802	-4.6
Crowd 1-based (βc1) group – total travel time less than 60 minutes	-0.3010	-3.4
Incremental factor		
+ Total travel time of 60 minutes or more	-0.3157	-1.7
Crowd 2-based (βc1) group – total travel time less than 60 minutes	-0.9486	-13.3
Incremental factor		
+ Total travel time of 60 minutes or more	-0.4079	-3.1
No. of observations	14,688	
ρ^2 with respect to constants	0.1007	

4.2 Analysis of the result

Based on the model in Tables 1-4, the values of the services were calculated and presented in Table 5.

The average value of time in all cases was 1.27 baht per minute. This result was slightly higher than in the previous studies, which suggested that the average value of time was 0.80 baht per minute. Interestingly, the result showed that wait time was valued at only 15 percent higher than the in-vehicle travel time, which is not consistent with the value of wait time in developed countries (as high as 2–4 times that of the value of time). This may be because the traffic situation in Bangkok is very congested, on-board bus conditions are not comfortable, and buses are usually crowded. Thus, the time spent riding the bus (mostly standing) is not much more pleasant than the time spent waiting for the bus. This is very different to the situation in developed countries, where the wait time is valued at about twice the value of the in-vehicle travel time. However, the value of interchanges was much more than the value of the level of crowding. The result of the value of level of crowding can be interpreted as passengers willing to travel 22 or 35 minutes longer on a bus to avoid one or two interchanges, respectively. Moreover, passengers were willing to wait 14 minutes at a bus stop for an uncrowded bus.

The results also show that the values were influenced by trip purposes, travel time and vehicle ownership. The values of time and wait time for home-based work and home-based other trips are at the same level. Non-home-based trips, which usually are business trips during the day, had higher values of time than home-based work trips. Surprisingly, home-based school trips had the highest values of travel and wait times, at 46 and 82 percent respectively, which were higher than the values of travel and wait times for home-based work trips. This situation may be because most students do not earn an income themselves and often are less patient than adults, so they are likely to be careless about spending money. This may be a reason that they are willing to pay more to save time.

Those who travel for longer than 60 minutes were more willing to pay more to save on travel time, have fewer interchanges, and travel on less

Table 5. Values of bus services in Bangkok

	Values of bus services in Bangkok						
	Preference for air-con bus (Baht)	In-vehicle travel time (Baht/min)	Wait time (Baht/min)	Interchange 1 time (Baht)	Interchange 2 times (Baht)	Medium Crowded (Baht)	Highly Crowded (Baht)
Mean	5.14	**1.27**	1.46	27.31	44.84	7.53	20.95
Segmentation analysis based on trip purposes							
Home-based work (HBW)	5.31	**1.14**	1.08	26.92	44.19	7.58	20.61
Home-based school (HBS)		**1.66**	1.97				
Home-based others (HBO)		**1.01**	1.05				
Non-home-based (NHB)		**1.44**	2.59				
Segmentation analysis based on travel time							
Less than 60 min.	5.00	**1.11**	1.45	23.18	40.23	5.97	18.80
60 min. or more		**1.72**		41.54	59.66	12.22	26.89
Segmentation analysis based on household vehicle ownership							
With no vehicle	5.20	**0.70**	0.77	24.81	37.54	5.27	13.34
With 1 car		**1.53**	1.90	26.07	43.14	7.64	21.53
With more than 1 car		**2.08**	2.03	32.27	55.34	11.05	30.36

crowded buses than those whose travel time was less than 60 minutes. As expected, households with more cars were also more willing to pay more to save on travel time, have fewer interchanges, and travel on less crowded buses, if they needed to travel by bus. This result is likely to be related to income effect.

5. CONCLUSIONS

Presented in this article are the results of research on the values of time and service qualities of bus transport in Bangkok. The average value of time in all cases was 1.27 baht per minute. This result was higher than that of previous studies. Interestingly, the result showed that wait time is valued at only 15 percent higher than in-vehicle travel time, which is not consistent with the value of wait time in developed countries. This situation may be because the traffic situation in Bangkok is very congested, on-board bus conditions are not comfortable, and buses are usually crowded. However, the value of interchanges was much higher than the value of level of crowding. The result concerning the value of travel on crowded buses can be seen in the percentage of passengers who are willing to travel 22 or 35 minutes longer on a bus to avoid one or two interchanges, respectively.

Furthermore, it was also found that the values were influenced by trip purposes, travel time and vehicle ownership. Non-home-based trips, which usually are business trips during the day, had higher values of time than home-based work trips. Surprisingly, home-based school trips had the highest values of travel and wait times, which were 46 and 82 percent, respectively, higher than the values of travel and wait times for home-based work trips.

As far as policy implications are concerned, the results provide insights into the valuation of the service quality of bus services in Bangkok. To make major improvements in bus services, it is necessary to take into account not only the travel time of the bus service, but also other quality aspects so that the demand prediction and the benefit evaluation would be much more accurate. However, much more research work remains to be done, especially on walk time and a detailed study of transfer time. These issues are very important to not only transport project evaluation, but also the development of the transport model.

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