EJTIR

Issue 9(4)
December 2009
pp. 397-410
ISSN: 1567-7141
www.ejtir.tbm.tudelft.nl

The Need for Advanced Public Transport Information Services When Making Transfers

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This paper reports on a stated choice experiment examining the determinants of travelers' need and willingness to pay for advanced public transport information services. Specific attention is given to the role of making transfers in the decision to acquire specific types of information. Intercity train travelers are asked to choose among information services that varied in type of information provided by the services, precision of provided dynamic travel time estimates, whether or not the system can provide information unasked for and price. Respondents made these choices conditional on a specified transfer context, denoting whether or not transfers had to be made during the trip, and whether these were transfers to high or low frequency train services. Modeling results indicate that as hypothesized, transferring during the trip, especially towards low frequency connections, induces a larger need for travel information, a higher preference for services that can provide advice relative to other information and a higher willingness to pay for information in general. However, the choice for information services is highly price sensitive, which suggest a low overall willingness to pay.

Keywords: contextual effects; public transport; stated preference; transfers; travel information; transit information

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1. Introduction

Due to the discrete nature of the departure of Public Transport (PT) services, missing a connection while making an interchange often substantially increases travel time, especially if one transfers towards a low frequency connection. If public transport services are carried out with 100% reliability, interchanges even towards low frequency services would not severely

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increase travel time, provided that the services are well-connected. Unfortunately, in many countries absolute reliability of PT services is not garanteed, for example, in the first quarter of 2006 1 out of each 8 trains of the Dutch Railways trains departed too late. In such circumstances, PT travelers may develop a need for advanced public transport travel information helping them avoid potential delays and/or organizing alternatives, which may reduce travel time and provide other benefits such as contacting on time the people with whom they have appointments (e.g. Hickman and Wilson, 1995; Kitamura et al.,1995; Abdel-Aty. 2001; Ouwersloot et al., 1997).

Such advanced public transport information is becoming more and more common nowadays, as rapid technological developments in mobile communications have induced telecommunication companies, transport agencies, governments and academia to further develop Advanced Travel Information Systems (ATIS, e.g., Adler and Blue, 1998; Chorus et al., 2006a). Whereas traditional travel information services mainly provide static pre-trip information on departure and arrival times of a single mode, developments in ATIS have moved in the direction of enabling the provision of personalized real-time (dynamic) multimodal en-route information, enabled by mobile communication equipment and location position technology. Moreover, if the information system knows where the traveler is headed, it may provide advice on its own initiative, for example, offer alternative routes or modes if a trip cannot be made as planned due to congestion or other delays.

While static information can usually be acquired free of charge, travelers typically have to pay for the next generation ATIS services because developing and exploiting such services is rather expensive. The literature generally provides evidence of a low willingness to pay for information provided through current advanced travel information services among travelers in general (e.g., Khattak et al, 2003; Wolinetz et al., 2000) and specifically for PT-information by PT-users (Molin and Chorus, 2004). The willingness to pay for travel information of PT users appears even to be lower than of car-users (Wolinetz et al., 2000), as many PT-users feel that they have already paid for travel information by purchasing a public transport ticket (Neuhertz et al., 2000). However, insights reported on existing information services may not apply for the new generation ATIS described above, as the latter services deliver functionalities that go well beyond the current ones.

This aim of this paper is to examine the PT-users need and are willing to pay for advanced PT information services. To that effect, we report the results of a Stated Choice experiment, in which public transport users chose among hypothetical advanced PT-information services. Special attention is paid to the role of making interchanges. From the literature can be learned that PT-users place severe penalties on interchanges during the trip (Hickman and Wilson, 1995; Nielsen, 2000; Wardman, 2001; Cherchi and Ortuzar, 2002, Hoogendoorn-Lanser and Hoogendoorn, 2000), value transfers according to the risk of missing a connection (Wardman, 2001), attach a relatively high utility to high-frequency services (Wardman, 2001; Friman and Gärling, 2001; Cherchi and Ortuzar, 2002), and value transfers to low-frequency services much more negatively than to high-frequency services (Bovy et al., 2003). Therefore, the hypothesis is tested that the need and willingness to pay for advanced PT information services increases, when travelers have to make an interchange during their trip and that this further increases as the interchange is towards low frequency connection.

This paper is organized as follows. First, the construction of the choice experiment, the response group characteristics and the model estimation are discussed. This is followed by a discussion of the choice experiment results. This paper finishes by drawing conclusions concerning the market potential of advanced PT information services and discussing policy implications.

2. Methodology

In this section, first the construction of the choice experiments is described. This is followed by a description of the way the data are collected and a description of the response group. Finally, the model estimation process is described.

2.1 Construction of the choice experiment

Four attributes are selected to construct the PT information service alternatives to be included in the experiment. A first attribute varied is the *type of information* the service provides. This attribute is varied in the levels: i *only times*; ii *times and search possibilities* and iii *times and advice*. The *only times* level refers to the basic functionality of any information service that is the provision of information on expected departure and arrival times. The *times and search possibilities* level refers to the additional functionality that allows the traveler to search for alternative modes of transport or routes. However, travelers themselves have to actively evaluate the found alternatives, which takes time that travelers may not have when they are approaching an interchange location and have to make a decision about taking an alternative route under time pressure.. Finally, the *times and advice* level points to a more advanced service that additionally provides advice on the best alternative available, given where the traveler is located, to where he or she wants to travel to and at what time, thereby taking into account the current state of the transportation network and the traveler's travel preferences. By this functionality it takes less time to reach decision on alternative routes, which may make the difference between just catching a connection instead of missing it.

In addition to a traveler that is actively inquiring information, it is conceivable that an information system itself takes the initiative to provide information. Once the information system is aware of the travel plans and the trip cannot be made as planned, the system may take the initiative to provide information. The information system then functions as an agent that constantly compares the traveler's plans with the state of the current and predicted transportation network and reacts when action is required. Although an additional feature of information systems, the traveler may not like the idea that information is provided unasked for. To examine this, the attribute *initiative by* is included in the experiment and varied in the levels *traveler, information service* and *both.*

To examine the role of reliability of the information provided, an attribute on the maximum deviation time is included. This attribute denotes how many minutes earlier or later a PT vehicle may depart in deviation from a dynamic departure time announced by the information system. This attribute is varied in the levels *0, 2.5* and *5 minutes.* It was told to the respondents that the maximum indicated deviation occurred in only 5% of all information messages.

Finally, in order to examine the willingness to pay for public transport information, the attribute *price per information message* is included. This attribute is varied in the levels *zero euro cents*, thus for free, *15 euro cents* and *30 euro cents.* The *zero cents* level means that the information service is completely subsidized, for example, by the transportation companies who like to retain their customers or try to attract new ones, or by the central government, who likes to induce a modal shift towards public transport by stimulating the provision of advanced travel information.

The selected attributes and their levels were then combined to arrive at PT information service alternatives based on the smallest possible orthogonal fraction of the 3^4 full factorial design, resulting in 9 choice alternatives. This design allows one to estimate all main effects, thereby assuming that all interaction effects did not play a role, hence, are equal to zero. These nine alternatives were randomly placed in choice sets of three alternatives each, to which a base alternative *none of these* was added, resulting in three choice sets. This process was repeated nine times to avoid any effects of choice set composition.

In order to test the hypothesis that the need to transfer during the trip, especially to a low frequency connecting service, increases travel uncertainty and therefore increases the need and willingness to pay for travel information, three transfer contexts were distinguished in the choice experiment. In the first transfer context, travelers have to make choices among the hypothetical information services assuming that they do not need to transfer to another PT vehicle in order to reach their final destination station. In the second context, traveler have to assume that they transfer to a train service running with a high frequency, more specifically running six times per hour. In the third context, travelers have to assume that they transfer to a low frequency train service running only once an hour. Furthermore, travelers have to assume that the train service from which they have to transfer runs with the same frequency as the service they are currently traveling in (respondents were recruited in public transport vehicles).

Each of the three transfer contexts was then randomly paired with one of nine choice set combinations. This was repeated three times, hence, arriving at 3 variants of the experiment. Each respondent was randomly assigned to one of the three variants, hence, was presented nine choice sets, that is, three choice sets per transfer contexts. Respondents were requested in each of the nine choice sets which of the three PT information services they would use given the specified transfer context, or choose the option *none of these.* The choice experiment was included in a self-explaining questionnaire that was handed out to respondents in intercity trains. The completion of the questionnaire took about 10 minutes on average.

2.2 *Response group*

Respondents were recruited in intercity trains in June 2004. Intercity trains were chosen because these have fewer stops, which gave respondents sufficient time to complete the questionnaire between two stops. Two lines were chosen: a line offering per hour four intercity trains, two fast trains and two stopper trains and a line offering per hour two intercity trains, two fast trains and in the rush hour two stopper trains. Data were collected during three average weekdays, roughly between 11.30 and 17.00 hours, which means that most of the respondents traveled before and a small part in the evening rush hours.

After travelers agreed to cooperate to a research on PT travel information, they were handed a questionnaire. The interviewer collected the completed questionnaires just before the next stop or picked them up from the respondents' seats after the train had stopped. Although it was not administered whether an individual traveler agreed to participate or not, the agreement rate could be estimated afterwards. Based on an estimate of seat occupancy of the visited train carriages and the number of distributed questionnaires, it was estimated that about 40% of all travelers agreed to respond. In total 246 questionnaires were distributed of which 239 have been recollected: 204 (82.9%) of the recollected questionnaires were completely filled out and analyzed in this paper. The total response rate can thus be estimated as about one third of all travelers of the train carriages visited, which is considered a normal response percentage for written questionnaires in the Netherlands.

The response group characteristics are presented in Table 1. More women responded than males (56.9% vs. 43.1%). Furthermore, the youngest age group is well represented. This is probably caused by the fact that in the Netherlands all college students have a free public transport card, the choice of lines on which the data were collected, and by the time of day the data were collected. The data mainly were collected on lines connecting cities that have large universities and many higher occupational schools. Furthermore, the data were collected in the afternoon when many students return home. This is also reflected in the trip purpose *school*, which was the most often-mentioned trip purpose (29.4%). However, if the trip purposes *work* and *business* are combined (40.6%), most of the respondents travel for work related purposes.

Table 1. Response group characteristics (N=204)

gender		age		trip purpose	
male	43.1%	<= 24 years	42.6%	work	22.5%
female	56.9%	25-50 years	45.1%	school	29.5%
		>= 50 years	12.3%	business	17.2%
				recreational	18.1%
				other	12.7%
travel frequency		perception train frequency			
>=4 day per week	31.9%	<= 2 per hour	40.4%		
1-3 days per week	24.0%	3-4 per hour	43.8%		
at least 1 per month	28.9%	> 5 per hour	15.8%		
less 1 per month	15.2%				

Furthermore, only a small part of the respondents (31.9%) can be considered as a daily user of the line they are currently traveling on. The largest group (44.1%) travels even less often than once a month on that line. Table 1 also presents the perception of the frequency of the line they currently traveling at: 40.4% perceives that the frequency is twice or less per hour, 43.8% that it is 3 or 4 times per hour and only 15.8% that it is 5 or more times per hour. Hence, train travelers perceive the frequency as lower than the actual frequency (which is described above) on the investigated lines. This misperception may have been caused by the large number of travelers than do not travel regularly on that particular line and by the possibility that Intercity train travelers do not take fast and stopper trains into account. Such misperceptions of PT-characteristics among travelers, even those who regularly use PT, are also found in other studies (e.g. Bonsall et al., 2004). Table 1 indicates that all distinguished categories are reasonably well represented and thus that the response group is a rather heterogeneous group.

2.3 *Model estimation*

It is assumed that travelers in each choice set choose the alternative from which they derive the highest utility. Following the theoretical assumptions behind random utility models (McFadden, 2001), it is assumed that the analyst is unable to determine exactly the utility travelers derive from each alternative, e.g. due to variation in unobserved attributes. Therefore it is assumed that the total utility a traveler derives from an alternative is composed of a systematic as well as a random error component. The systematic or non-random part of the utility travelers derive from choosing an information service is assumed to be a linear-additive function of relevant service attributes and the decision-maker's tastes. When assuming that the additional random error term is iid (independently and identically distributed)-extreme value distributed, the straightforward Multi Nomial Logit (MNL) model can be applied to estimate the coefficients for different attributes.

However, for the current dataset the MNL-model may be too simplistic as it is unable to account for the fact that individuals may differ in their tastes regarding the (observed and unobserved) attributes of alternatives. Furthermore, in our experiment each individual made multiple choices, which are expected to correlate to some extent. Hence, a model is needed that does acknowledge that tastes i) may differ between individuals and ii) remain stable for different choices made by the same individual, thus inducing correlation between these choices. A Mixed Logit model for panel data meets these criteria. The unit of observation then becomes the full sequence of choices made by the same individual, rather than each individual choice made, and tastes (parameters) are allowed to vary randomly within the population. The probability of observing a particular sequence for an individual now becomes a product of Logit-probabilities, one for each choice made by the individual, which is mixed over the density function of the random parameters. See for example Train (2003) for mathematical derivations of the choice probabilities for alternatives using this Mixed Logit model for panel data, allowing for taste heterogeneity.

The above model is estimated from the choices observed in the choice experiment for each of the four alternatives in the 27 information service – transfer choice sets. In order to include categorical attributes in the analysis, like information type and initiative, numerical values have to be assigned to the attribute levels. The most widely applied coding scheme is dummy coding, which in the case of a two level attribute involves that one level is coded by 0 and the other level 1. A disadvantage of this coding scheme, however, is that the estimated constant then coincides with the utility derived from the alternative with all 0 coded levels, which may cause interpretation difficulties. Effects coding is an alternative coding scheme that does not have this disadvantage (e.g., Louviere et al. 2000 and Bech and Gyrd-Hansen 2005) and allows an own interpretation for the estimated constant, which is explained later on.

By applying effects coding, the 0 is replaced by -1 as illustrated in Table 2 for three level attributes. In general, L levels are coded by L-1 indicator variables, for each of which a coefficient ßl is estimated. The marginal utility or part-worth utility contribution of an attribute level to the overall utility is then calculated by multiplying each estimated coefficient with the codes on the indicator variables and summing these results. In case of three level attributes, this involves that the part-worth utility of the first level is equal to the coefficient estimated for the first indicator variable, thus ß1; the part-worth utility of the second level is equal to the coefficient estimated for the second indicator variable, thus to ß2; and the part-worth utility of the third level is equal to -ß1- ß2. Consequently the sum of the part-worth utility contributions across the levels of an attribute is equal to zero.

Table 2. Effects-coding for three-level attributes

levels	indicator variable 1	indicator variable 2	part-worth utility
1	1	0	$ß_1$
2	0	1	$ß_2$
3	-1	-1	$-ß_1-ß_2$
estimated parameters	$ß_1$	$ß_2$	

As earlier stated, the interpretation of the constant does not coincide with the zero coded categories as with dummy coding, but has its own interpretation. To that effect, the hypothetical information services alternatives were coded by 1 and the alternative 'none of these' with 0. The estimated constant for this indicator variable can then be interpreted as the average utility travelers derive from the information services included in the experiment compared to the alternative *none of these*, which has a utility of zero by definition. More loosely interpreted, the estimated constant can be interpreted as the need for travel information services (at least for those presented in the experiment). Hence, differences in the estimated constant across the three transfer contexts indicate differences in the need for information services caused by the applying transfer condition.

With the estimated constant represents the average utility derived from the hypothetical services, an estimated part-worth utility indicates to what extent the presence of an attribute level changes the average utility. This part-worth utility is expressed in terms of the deviation from the estimated constant. Hence, a positive part-worth utility implies that the presence of the attribute level increases the utility derived from an information service, while a negative part-worth utility decreases the utility.

A further advantage of applying effects coding to all variables, thus also to continuous variables such as price, is that the values of all attributes are expressed on the same scale (-1 to +1), which enables a direct comparison of the strength of the estimated coefficients across attributes so as to examine the relative impact of each attribute on choice. A final advantage of this coding scheme is that it provides an easy way to test whether utility is linearly related with varying levels of continuous attributes. In case of three level continuous attributes, as in this study, one may conclude that a relationship is linear if the coefficient estimated for the second indicator variable is not statistically significant. It can easily be seen in the last column of Table 2 that if $ß_2$ equals zero, the part-worth utilities for the three attribute levels become $ß_{1,}$ 0 and $-ß_1$.

Applying effects coding for all attributes and transfer context and applying dummy coding for the information service constant resulted in the coding schema presented in Table 3. In order to test whether the transfer context influences information service choice, coefficients are estimated for the interactions between the two travel context indicators and all other indicator variables. Hence, significant coefficients for those interaction effects indicate that utility contributions differ with transfer context, hence, that transfer context influences information service choice.

Table 3. Applied coding scheme

attributes	levels	indicator variables	
		constant	
constant	information service	1	
	none of these	0	
context		context1	context2
	no transfer	1	0
	towards high freq.	0	1
	towards low freq.	-1	-1
information type		infotype1	infotype2
	only times	1	0
	times & search	0	1
	times & advice	-1	-1
initiative		initiative1	initiative2
	traveler	1	0
	information service	0	1
	both	-1	-1
unreliability		unreliabilty1	unreliability2
	0 minutes	1	0
	2.5 minutes	0	1
	5 minutes	-1	-1
price per message		price1	price2
	0 cents	1	0
	15 cents	0	1
	30 cents	-1	-1

3. Results

3.1 The estimated models

The models are estimated by using the econometrical software package Limdep/Nlogit. First an MNL model was estimated to serve as a base reference model. In total, 27 coefficients were estimated: an information service constant, 8 coefficients for the indicator variables representing the 4 information service attributes and all their interactions (18) with the two indicator variables of the transfer contexts. As many of these coefficients turned out to be not statistically significant at the conventional 5% significance level, the none-significant coefficients were removed from the estimated utility function to arrive at a more parsimonious model. The statistically significant coefficients of the final model are presented in the first results column of Table 4.

Only the significant coefficients were then included in the mixed logit model, except for the attribute *initiative.* Although this attribute was not significant in the MNL model, this did not imply per se that the attribute did not influence information service choice, because taste heterogeneity may exists among travelers. Positive and negative tastes then cancel out at the aggregate level. In order to test whether taste heterogeneity exists, a standard deviation for this attribute can be estimated. A statistically significant standard deviation indicates taste heterogeneity, while a none-significant standard deviation indicates that the attribute did not play a role (neither at the aggregate, nor at the individual level).

Furthermore, it was decided to allow only the first indicator variables (i.e., the linear components) of each attribute to vary across individuals, as only the coefficients for these indicator variables turned out to be statistically significant in the MNL model (except for price, but the magnitude of the estimated effect was very small). For the *constant,* and the attributes *information type* and i*nitiative* it was assumed that individual parameters can take positive as well as negative values and therefore a normal distribution was assumed. For the attributes *unreliability* and *price* it was assumed that all individuals would derive a lower utility from higher attribute values, hence, the individual parameters should all have the same sign. More specifically, as presented in Table 3, low values of these attributes were coded by +1 and high values by -1, hence, a positive coefficient is expected. In order to assure that all coefficients are positive, a lognormal distribution was chosen.

The mixed logit model, acknowledging the panel structure of the dataset and taste heterogeneity with respect to the randomized variables, was estimated by taking 1000 Halton draws from the assumed distributions. This number appeared to be sufficient, as the random coefficients did not change more than a single standard error compared to a model based on 500 Halton draws.

Table 4 presents the coefficients of the estimated mixed logit model.. The LRS test indicates that the mixed logit model with 4 additional coefficients resulted in a statistically significant improvement of model fit compared to the MNL model (Chi-square = 2*(-1982.509--1700.348)=564.322, 4 degrees of freedom, p = 0.000) and is therefore the preferred model. This is also illustrated by the substantially higher adjusted Rho-square value of 0.330 versus the 0.222 value of the MNL model. From this result one may conclude that the MNL-model's assumptions of a) taste homogeneity and b) independency between choices made by the same respondent were indeed too restrictive. The standard deviations for the constant, and for the indicator variables infotyp1, unreliability1 and price1 are highly significant, which indicates that taste heterogeneity for their corresponding attributes exists.

The magnitudes of the coefficients in the mixed logit model are generally larger than those in the MNL model. This is to be expected as in the Mixed Logit model part of the variation in unobserved or random utility is captured by the estimated standard deviations. The remaining iid-error component in the Mixed Logit model has therefore a smaller variance than the iid-error component in the MNL-model. Given that the variance of the iid-error is normalized to 1 in both models, this implies that parameters have a larger absolute value in the Mixed Logit model (e.g. Revelt and Train, 1998).

A coefficient β^k follows a lognormal distribution if the log of β^k is normally distributed. As a consequence, the lognormal distribution can be parameterized in terms of the underlying normal. That is, parameters *m* and *s* can be estimated that represent the mean and variance of the log of the coefficient: $\ln \beta^k \sim N(m, s)$. The median, mean and standard deviation of the normal distribution can be calculated from the estimated coefficients as follows (Train 2003, p. 153-154): median = exp(m); mean = exp(m +s^2/2) and the standard deviation = exp(2m + s^2)*exp(s^2)-1. Hence, the point estimates for the attribute *unreliability* are as follows: median = .18, mean = .39 and standard deviation = .79; and for the attribute *price*: median = 1.88, mean = 2.92 and standard deviation = 3.48. The means are used to calculate the part-worth utilities that are discussed in next subsection.

Table 4. Estimated coefficients of MNL and Mixed Logit Models

MNL	MNL		Mixed Logit	
	coeff.	t-ratio	coeff.	t-ratio
coefficients (average across transfer contexts)				
constant	0.11	1.684	0.90	2.912
infotype1	-0.26	-6.050	-0.32	-4.801
unreliability1	0.22	4.611	-1.74	-4.931
price1	1.46	27.717	0.63	7.008
price2	-0.18	-3.263	-0.05	-0.783
interactions with transfer context				
context1 * constant	-0.31	-3.571	-0.63	-5.019
context2 * constant	0.42	4.506	0.86	6.446
context2 * infotype1	-0.13	-2.759	-0.19	-3.650
context2 * price1	-0.22	-3.614	-0.32	-4.026
standard deviations				
constant			3.24	9.715
infotype1			0.57	7.686
unreliability1			1.27	5.240
price1			0.94	8.842
Loglikelihood at convergence	-1982.509		-1700.348	
Adj. Rho^2	0.222		0.330	

3.2 *Interpretation of estimated coefficients*

The coefficients of the mixed logit model estimated for the indicator variables can be considered as averages across the three transfer contexts. Only if coefficients estimated for the interaction of the indicator variables with any of the transfer context indicators are statistically significant, attribute-tastes differ among the travel contexts; otherwise, their effect is the same in three transfer contexts. In this subsection, we focus on the average impacts across the three transfer contexts, while in the next subsection, we focus on the difference across the transfer contexts.

First of all, we focus on the coefficients that are not included in the model. Both the mean and the standard deviation for the attribute *initiative* did not become statistically significant. This suggests that this attribute did not play role in information service choice. Assuming that respondents fully grasped the meaning of this attribute, this result suggests that respondents are indifferent with respect to who takes initiative, the traveler or the information service (or both).

Furthermore, of the remaining attributes, only the coefficients estimated for the first indicator variables turned out to be statistically significant. While in the MNL model the second indicator variable for price was statistically significant, though its magnitude was rather small, this coefficient did not become statistically significant in the mixed logit model. Hence, this result indicates that utility linearly decreases with increasing price for information messages. This result is somewhat different from results reported by Molin and Timmermans (2006), who found that an increase in price from a free PT information service to a paid service had a much higher impact on travel information choice than a further increase of price by the same amount. Possibly this is caused by the much wider price range used in that research or by the fact that the information services in that paper were less advanced, for which travelers may have a lower willingness to pay.

Furthermore, also for the attribute *unreliability* it is found that utility linearly decreases with increasing values. This means that every minute more imprecision of provided dynamic information has an equal decrease in utility as a result. To some extent, this was unexpected, as one would guess that an initial deviation of 1 minute would have a smaller utility impact that an increase from 4 to 5 minutes. Furthermore, the magnitude of the coefficient is smaller than expected. Possibly this is caused by the fact that travelers had to assume that in only 5% of the messages the presented deviation between the expected departure time in the real departure time would occur. Hence, this result suggests that travelers tolerate this low frequency of occurrence and perceive that the advanced information service provides rather reliable information.

With respect to the attribute *information type,* a non-significant second indicator variable means that an increase in functionality of the level *times and search* to the level *search and advice* increases utility to the same extent as the initial increase in functionality from the basic *times only* to the more advanced level *times and search possibilities.* This implies that travelers value the functionality *advice* in information services, hence, the functionality that finds alternative routes and orders these in terms of individual preferences of the individual traveler.

The estimated constant averaged across the three transfer contexts is equal to 0.90. This means that on average, the information service alternatives included in the experiment received a higher utility than the base alternative *none of these*, which was given a utility of zero by definition.

Considering the magnitudes of the estimated coefficients, it is clear the price has the largest impact on information service choice. This suggests that the demand for advanced travel information is highly price sensitive and confirms earlier findings in that regard (Khattak et al., 2003; Wolinetz et al, 2001; Molin and Chorus, 2004; Neuhertz, 2000). The attributes *information type* and *unreliability* have fairly the same impact on information service, but their influence is much lower than price. Finally, as discussed earlier, the attribute *initiative* does not have an impact on information service choice.

3.3 Impact of transfer context

This subsection focuses on the differences found between the three transfer contexts. Of 18 tried coefficients for interactions between indicator variables and context indicators, only four interaction coefficients turned out to be statistically significant. These will now be discussed in turn.

The interaction of both context indicators with the constant are found to be statistically significant, which means that the need for travel information in general differs among the transfer context. The estimated interaction coefficients indicate to what extent the constant in each of the three transfer contexts differs from the constant averaged across three contexts (0.90). Taking into account the coding of the travel contexts as presented in Table 3, it appears that the constant in the *no transfer* context is 0.63 lower than the average, and thus equals 0.27. The constant in the *low frequency* transfer context is 0.86 utility points higher, and thus equals 1.76. Finally, the constant in the *high frequency* context differs -1*(-0.63+0.86) = -0.23 from the average constant and is thus equal to 0.67. This indicates that in all three travel contexts the mean utility attached to the presented information services is higher than the option *none of these,* which indicates a certain need for information services in all three context exists. Furthermore, the need for information services differs among the three transfer contexts as hypothesized: the need increases if one moves from the *no transfer* context to the *high frequency* context and increases considerably further if one moves from the *high frequency* context to the *low frequency* context.

The significant interaction coefficient of infotype1 and context2 indicates that in the *low frequency* context, the coefficient infotyp1 is -0.19 lower than average coefficient across all contexts (-0.32). Hence, if travelers have to transfer to a low frequency service, they derive a higher than average utility from the additional functionality *advice,* while they derive a lower than average utility from information services that offer *only times.* The coefficient in the *high frequency* context differs +0.19 compared to the average across all contexts, whereas the coefficient for the *no transfer* context does not differ from the average. This means that if travelers have to transfer to a high frequency service, they value advice less compared to a situation in which they do not need to transfer. This is an unexpected finding, as one would expect that a transfer would be perceived as a more uncertain travel condition compared not transferring and therefore would increase the need for advice.

Finally, the interaction between price1 and context2 was found to be statistically significant. The coefficients indicates that the coefficient for price1 is 0.32 lower for the *low frequency* context, whereas it is 0.32 higher in the *high frequency* context, while it does not differ from the average in the *no transfer* context. Hence, the utility range (the difference between the lowest and highest part worth utility) becomes smaller in the context *low frequency* context, meaning that price is less important and thus people are more willing to pay for travel information in a potentially more uncertain travel context. On the other hand, the results for the *high frequency* context suggest that travelers are less willing to pay for information in more certain travel contexts, even less than in the *no transfer* context. The latter is an unexpected finding.

Except for the two unexpected findings just discussed, all coefficients have the expected sign.

4. Conclusion and discussion

In this paper, the need and willingness to pay for advanced public transport information services conditional on potentially uncertain travel conditions was examined. To that effect, a stated choice experiment was constructed that allowed the observation of choices among hypothetical information services separately for three different transfer contexts: no transfer, transfer to a high frequency service and transfer to a low frequency service. The results largely confirm our hypothesis that the need and the willingness to pay for information services increases if travelers have to transfer during their trip, certainly if they have to transfers to low frequency connections. Contrary to expectations, we found that the need for advice and the willingness to pay is lower if travelers have to transfer to high frequency services during their trip, although on average the need for travel information is still higher in the *high frequency* context than in the *no transfer* context.

The results suggests that mentioning *transferring to high frequency connections* impacts travel information service choice in a way we do not fully understand yet. More research on this is clearly needed. Furthermore, in future research the operationalization of the attribute reliability of information might be improved. Firstly, the direction of the deviation was not indicated, hence, we did specify whether the PT vehicle left earlier or later than predicted by the information service. Travelers may value PT vehicle leaving earlier than predicted as more negative compared to PT vehicle leaving later than predicted, as the former may cause them to miss the service. Secondly, travelers are told that only in 5% of all messages, the presented deviation in minutes occurs. This may be an acceptable occurrence rate for travelers, and therefore the deviation is trivialized. Hence, larger rates of occurrence may be considered.

The results presented in this paper may be used by public transport companies that offer low frequency-services that include transfers. They may consider providing their customers with adequate, high-quality information, in order to maintain their customer base. This may for example be the case if services are rescheduled with the results that part of the travelers have to make more transfers. As the reported results indicate an increased need for travel information under such conditions, this suggests that low-quality information formats, such as providing travel times only, may no longer fulfill the travelers' needs. More advanced services may then be more adequate as these provide travelers with advice that is tailored to their personal preferences and their location in the transport network.

Furthermore, the results indicate that on average, travelers are indifferent on who takes the initiative to provide travel information: travelers themselves or the information service. This result suggests that travelers do not dislike the idea that advanced information services provide information unasked for. If the results of this study based on responses from train travelers could be generalized to car drivers, this offers possibilities to provide car drivers with public transport information unasked for. When informed on public transport, car drivers may be induced to change to public transport when faced with congestion and therefore advanced PT information services may contribute to relieving congestion problems. However, this topic clearly needs more research.

Although advanced traveler information systems certainly appear to have the potential to retain PT customers and perhaps even to attract more car drivers to public transport (although the latter potential is often debated (Chorus et al., 2006b)), it is uncertain whether personal advanced travel services will be further developed because of its high price sensitivity, meaning a rather low willingness to pay for these services on average. The results also point out that there is a wide spread in the willingness to pay values among the travelers, indicating that part of the travelers are willing to pay for advanced travel information. An interesting topic for further research is therefore to identify this group of travelers.

If future research points out that these information services can really induce a modal shift towards public transport and the willingness to pay for a large share of travelers remains low, central governments may consider subsidizing these systems as they may help solving accessibility problems.

Acknowledgements

This paper has been written in the context of the PITA program, which is a collaboration between the Delft University of Technology and the Eindhoven University of Technology, and sponsored by NWO-Connekt.

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