FACTORS WHICH INFLUENCE THE PREFERENCES FOR REAL-TIME PUBLIC TRANSPORT INFORMATION

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1. ABSTRACT

This paper presents the results of a study undertaken in Dublin, to ascertain preferences for real-time public transport information. This study examines the need for public transport information across three stages of a public transport trip. The stages examined are as follows; stage one: pre-trip planning from home to work, stage two: at-stop/station information and stage three: pre-trip planning from work to home. At each of these stages the respondents were asked to choose between several methods of receiving information, via the internet, mobile phone, call centre or at stop real-time information displays. The study utilised a stated preference approach to ascertain what type of information is demanded at each stage and the willingness to pay amounts for this information.

Specifically, this paper will focus upon the factors that influence the choice of real-time transport information option. Several factors from the literature have been proven to impact upon the utility derived from real-time public transport information. The results from this study are compared against the factors from the literature which have been proven to impact upon utility, to validate the findings of this study. The paper concludes with summary of the main findings of this study and how they contribute to the field of knowledge in this research area.

2. INTRODUCTION

Real-time transit information is an individual specific travel demand management tool, which is used to facilitate individuals while planning their transit trips. The provision of such information has been shown to encourage individuals to examine their transit options and to choose the service which meets their requirements. This research examines individuals' preferences for accessing real-time transit information across three stages of their trip to and from work. To examine these preferences a stated preference study was conducted to ascertain how respondents would value the introduction of several transit information tools such as at-stop/station displays, a call centre, mobile phone-based information and web-based journey planners.

3. LITERATURE REVIEW

This section presents literature on the individuals most likely to use such information, willingness to pay estimates for transit information and the perceived reduction in wait-time due to the introduction of real-time information.

The type of individual most likely to use real-time transit information

A study conducted in San Francisco in 2002 examined the type of individuals who were more likely to use TravInfo, a journey planner which provides traffic and multi-modal information (Youngbin et al 2002). The authors of this study found that individuals who were more inclined to use such technology were termed 'early adaptors'.

In 2001 a study conducted in Northern California using a computer aided telephone survey examined respondents' preferences for real-time information, to ascertain how several characteristics impact upon the use of transit information (Abdel-Aty, 2001). The findings of the survey found that respondents required information on the number of transfers, seat availability, walking time to transit stop, fare information and frequency of service.

Willingness to pay for real-time information

In a transit network with a large number of passengers transferring between different modes, the requirements for accurate real-time information increases. In Hong Kong it is estimated that up to a fifth of passengers make a transfer during their daily commute (Tam & Lam, 2005). In a study conducted in Hong Kong to examine passengers' preferences for real-time information, it was found that respondents derived the greatest benefit from information delivered via a mobile device, either by a mobile phone or a personal digital assistant (PDA). The authors found that as travel time and trip complexity increased, so too did the likelihood that an individual would choose to access real-time information using short message service (SMS) or a PDA. The results also demonstrated that females, those on higher incomes and those on a monthly mobile phone contract were more likely to choose to obtain real-time information. The willingness to pay amounts from the study show that, 53% of respondents were willing to pay $100 (USD) per month and 20% $200 (USD) per month, to avail of real-time transit information via SMS.

A study conducted in the Netherlands in 2005 examined the benefits of providing real-time transport information via the internet (Moiln and Timmermans, 2006). The authors of this study administered a stated preference survey to intercity rail passengers to ascertain their preferences for transit information via the internet. In the survey, respondents were asked to rank the importance of several attributes of a web-based transit information system. The results found that the provision of real-time information was the most important aspect, followed by the availability of planning options and purchasing tickets. The respondents to the survey were found to be willing to pay 26c per minute to access real-time transit information via the internet.

In 2001 a survey was conducted in San Francisco, to identify respondents' preferences for real-time transport information via a call centre (Wolinetz, 2001). Initially respondents were asked to identify their preference for paying for the service. 17% indicated they would pay on a monthly basis, 56% on a call by call basis and 22% said they would not use the service if they had to pay. 53% were found to be willing to pay up to $1 (USD) per call and 38% indicated they would pay up to $7 (USD) per month for this service.

A study conducted in the Netherlands in 2004, estimated willingness to pay amounts for real-time transit information via SMS (Molin and Chorus, 2004). This study was conducted on bus users in the Netherlands using an on-line survey tool. The authors estimated an average willingness to pay per message of 12c. The study also concluded that those with a higher education, males and those on higher incomes were willing to pay more for receiving real-time transit information via SMS.

4. METHODOLOGY AND DATA COLLECTION

This section of the paper details the methodologies used to collect and analyse the data presented in this paper.

Data collection

The survey was conducted over a two-week period from the 18th April – 9th May 2005 using web-based methods. A controlled sample was taken of office workers in Dublin city centre. The selected companies were contacted via their human resources department and the survey was then sent out centrally to all employees. A total of 1,500 surveys were distributed to the employees of the companies targeted. 495 fully completed surveys were returned, resulting in a response rate of 33%.

Scenarios examined

In the survey respondents are asked to consider three scenarios, each of which is a stage of a transit trip. The first stage examined is the pre-trip planning stage from home to the respondents' place of work. At this stage it is assumed that the information will be obtained before the individual leaves his/her home to arrive at their transit stop/station. At this first stage respondents were offered the choice between accessing transit information from a call centre, from a transit web-site or via their mobile phone in the form of a SMS.

The second scenario asked respondents if they were at their transit stop/station which of the following they would use to receive transit information; at stop PID, from a call centre or via an SMS. The final scenario presented to respondents asked before leaving their place of work, which of the following they would choose to access transit information from, a call centre, transit web-site or via an SMS. The transit information options presented to the respondents were defined by three attributes; cost, wait-time saved and type of information.

Modelling approach applied

Discrete choice models are usually derived under the premise of a utility maximising consumer and therefore use random utility theory. This sub-section presents the main aspects of this theory. In random utility theory it is assumed that an individual will derive utility from alternatives J. The utility that one derives from alternative j, is $U_{nj}, j = 1, ..., J$. An individual will choose the alternative that he/she will derive the highest utility from. As stated in equation 1, the individual will only choose alternative *i*, if and only if the utility he/she derives from this alternative is greater than all the other alternatives in the choice set.

Equation 1

$$U_{in} > U_{ij} \forall j \neq i$$

In the case of this study, the respondent will only choose the real-time transport information option he/she derives the maximum utility from. Utility is assumed to be composed of a deterministic component V_i and a random component ε_i. The deterministic component can be measured, as this component is related to the alternatives in the choice set. The random section cannot be measured, and the most appropriate way to model this component is to assign a distribution to the random element and estimate the probabilities of choice. Therefore, in random utility models the utility expression is outlined in equation 2.

Equation 2

$$U_i = V_i + \varepsilon_i$$

As the random component cannot be measured, it is assumed to be set to a probability distribution defined by the model used to analyse the data (Train, 2003). As the random component cannot be modelled, the probability that individual *n* will choose alternative *i* can be expressed as in equation 3.

Equation 3

$$P_i = \Pr ob(U_i > U_j) \forall j \neq i$$

Therefore, the probability that the respondent will choose alternative *i* is the probability that the utility of that alternative is greater than any of the other alternatives in the choice set. These probabilities are then modelled using the multinomial logit model (MNL).

The MNL is one of the most widely used discrete choice models, used to analyse stated preference studies. The model is derived under the premise that the error term is identically and independently distributed or Gumbel distributed. This results in the probability of choosing an alternative as expressed in equation 4.

Equation 4

$$P_i = \frac{e^{V_i}}{\sum_{j=1}^{J} e^{V_j}}$$

P_i is the probability that the individual will choose alternative *i*, V_i is the deterministic element of utility for alternative *i* and *J* is the number of alternatives in the choice set. The coefficients presented in table 4 are then estimated using the maximum likelihood estimation procedure; see Train, 2003, Hensher et al 2005 or Louviere et al 2000 for a comprehensive review of this procedure.

5. SOCIO-ECONOMIC AND TRIP CHARACTERISTICS

Socio-economic characteristics

Table 1 presents demographic characteristics of the sample. The results show that 43.4% of the respondents were male, and 56.6% were females. In the questionnaire, respondents were asked to indicate their age using one of the five age bands; under 24, 25 – 34, 35-44, 45-54 and over 55. 42% of respondents were found to aged 25-34, and 24% were aged 35-44 and 21.0% age 45-54. Table 1 presents the reported incomes of the respondents to the questionnaire. The results show a wide distribution of income. 36.3% of respondents were found to earn between €20,000 and €50,000, and 40.9% earn between €50,000 and €100,000.

Characteristic		***N***	***%***
Gender	Male	215	43.4
	Female	280	56.6
	Total	495	100.0
Age	Under 24	35	7.0
	25 – 34	208	42.0
	35 – 44	119	24.0
	45 – 54	104	21.0
	Over 55	29	6.0
	Total	495	100.0
Income	Less than €10,000	9	1.8
	€10,001 - €20,000	26	5.0
	€20,001 - €30,000	69	13.7
	€30,001 - €40,000	58	11.8
	€40,001 - €50,000	53	10.8
	€50,001 - €60,000	61	12.3
	€60,001 - €80,000	77	15.6
	€80,001 - €100,000	64	13.0
	€100,001 - €120,000	37	7.5
	€120,001 - €140,000	18	3.7
	More than €140,000	12	2.5
	I do not wish to revel my income	11	2.3
	Total	495	100.0

Table 1, Socio-economic Characteristics of the sample

Trip characteristics

Table 2 details the characteristics of the transit trips taken by respondents to the survey. The survey was aimed at individuals who work in Dublin city centre and, as such, it was open to all individuals regardless of their mode of transport. The findings demonstrate that approximately a quarter of the respondents use a private car to get to work with 22.4% driving alone and 3.2% as passengers (See table 2). The proportion of individuals that either cycle or walk to work was 14.2% and 7.9% respectively. The remaining respondents in the sample (52.3%) used public transport, with the majority of these individuals using the bus, (28.7%) and the remainder using one of the light/heavy rail options.

Characteristic		***N***	***%***
Mode of transport	Walk	70	14.2
	Cycle	39	7.9
	Car (Drive)	111	22.4
	Car (Passenger)	16	3.2
	Bus	142	28.7
	Light rail	33	6.6
	Rail	83	16.7
	Taxi	1	0.3
	Total	495	100.0

Table 2, Trip Characteristics of the sample

Perceptions of current public transport information sources

The questionnaire asked respondents how they perceived the quality of the public transport information currently available in Dublin. The quality of maps at stop/stations, timetables, websites, information on the cost of a trip and the availability of real-time information were examined. Respondents were asked to rate these information options as; very good, good, average, poor and very poor.

55.1% of respondents indicated that they found the quality of maps provided at bus stops/train stations to be poor or very poor (see table 3). Few respondents (4.4%) found the quality of the maps provided to be very good and the quality of the timetables provided at stop/station were said to be poor or very poor by 41.0%. As with the quality of maps, 6.6% of respondents found the quality of timetables to be very poor.

42.3% of respondents indicated the quality of public transport web-sites to be good or very good, however, 26.3% of the sample said the quality was poor or very poor (see table 3). The availability of information on the cost of public transport was found to be poor or very poor by 52.3% of respondents. 29.5% of respondents said that the availability of information on the cost of public transport was average, and 14.0% indicated the current provision of information was good. Finally, this section asked respondents to rate the availability of real-time information currently available on public transport. 64.9% indicating the availability of real-time information was poor or very poor, with only 3.5% indicated that the availability of real-time information was very good (see table 3).

Option	***Very Good (%)***	***Good (%)***	***Average (%)***	***Poor (%)***	***Very Poor (%)***
Maps provided at bus stops/train stations	4.4	13.5	27.0	28.8	26.3
Timetables provided at bus stops/train stations	6.6	21.8	30.7	22.4	18.5
Public transport websites	8.8	33.5	31.4	13.6	12.7
The availability of information on the cost of your trip	4.2	14.0	29.5	27.6	24.7
Availability of real-time information on your trip	3.5	11.1	20.5	29.2	35.7

Table3, Perceptions of the quality of transport information currently provided

6. MODEL RESULTS

Model performance and interpretation

In the MNL models presented in this paper there are two methods of measuring model performance by examining the *t*-ratios and the $\rho^2(0)$ and $\rho^2(c)$ values. The coefficients *t*-ratio measures the level of significance of the variable in question. Values above ±1.9 indicate that the variable is significant at the 95% confidence level and above ±2.56 significant at the 99% confidence level. The variables estimated in models M1, M2 and M3 were all found to be significant at either the 95% or 99% confidence levels (Mittlehammer et al 2000) (see models M1, M2, and M3 in table 4).

The second set of values which determine the performance of the model are the $\rho^2(0)$ and $\rho^2(c)$ values. The $\rho^2(0)$ and $\rho^2(c)$ values are similar to the R^2 values used in the regression model, with values ranging between 0.2 and 0.4 indicating a good model fit (Train, 2003). The $\rho^2(0)$ and $\rho^2(c)$ values for model M1 in table 3, were found to be 0.251 and 0.207 respectively. The $\rho^2(0)$ and $\rho^2(c)$ values estimated for model M2 were 0.225 and 0.211 and 0.228 and 0.217 for model M3. The $\rho^2(0)$ and $\rho^2(c)$ values for each of the three models were found to be within an acceptable range, therefore each of the models presented represents a good model specification.

The estimated coefficients for wait-time saved were found to be negative in each of the models examined. The data used to represent a reduction in wait-time in the model was also negative. Therefore, there is a positive impact upon utility, as a negative coefficient multiplied by another negative coefficient only one can be defined as a coefficient results in a positive impact upon utility. The cost coefficients were also found to be negative for each of the models estimated. The data entered in the dataset of responses to represent cost were positive, therefore, a negative coefficient multiplied by a positive cost results in a negative effect on utility. Finally, the information variable was again found to be negative. In the data set, 0 indicated a preference for static information and -1 a preference for real-time information. Therefore, a negative coefficient multiplied by -1 (indicating a preference for real-time information) indicates respondents derive utility from real-time transit information.

MNL Model Estimates: Stage One

The coefficient values for wait-time saved at the first stage demonstrated that respondents derived the greatest benefit from a reduction in wait-time when using an SMS with an estimated coefficient of -0.063 (see model M1, table 4). The coefficients for the internet and a call centre were estimated at -0.039 and -0.021 respectively. These coefficients demonstrate that respondents derive the greatest benefit from wait-time saved when using an SMS at stage one. The cost of information coefficient was shown to be -0.021 for the SMS option and -0.037 and -0.056 for the internet and call centre options respectively (see table 4). These cost coefficients demonstrate that respondents were found to be least likely to object to paying for real-time information from an SMS followed by the call centre and the internet.

The estimated coefficients for the type of information (type of information refers to static or real-time information) were found to be negative and significant at the 95% or 99% confidence levels. Of the type of information coefficients, the coefficient for the SMS of -1.029 was found to be highest of all of the options examined at stage one (see model M1, table 4). This result demonstrates that respondents were found to derive the greatest benefit from real-time information when using an SMS. The findings from model M1 demonstrate that at the pre-trip planning stage respondents derive the greatest benefit from accessing transit information using an SMS.

MNL Model Estimates: Stage Two

The wait-time saved coefficients estimated for each of the options at stage two were all found to be negative and significant at the 99% confidence levels (see model M2 in table 4). These findings suggest that respondents derive the greatest benefit from a reduction in wait-time when using a PID at the second stage. Wait-time saved coefficients for SMS and call centre of -0.022 and -0.011 demonstrates that respondents derive a higher benefit from wait-time saved when using an SMS compared to a call centre. The cost coefficients demonstrate that respondents object the least to paying for information from a PID, as the estimated coefficient (-0.035) was found to be lower than those estimated for the SMS and call centre options (see model M2, table 4).

The type of information coefficients estimated at the second stage were all negative and significant at the 99% confidence level (see model M2, table 4). The negative coefficients demonstrate that respondents derive a greater benefit from real-time information as opposed to static information. The PID coefficient was estimated at -1.102 and the SMS and call centre coefficients were found to be -0.921 and -0.697 respectively. These results show that respondents derive the greatest benefit from real-time information provided by a PID followed by SMS and a call centre. The findings at the second stage indicate that the use of a PID at the second stage provides respondents with the greatest benefit.

MNL Model Estimates: Stage Three

The wait-time saved coefficients at third stage were found to be negative and significant at the 99% confidence level (see model M3, table 4). The cost coefficient for SMS was found to be -0.044, which was found to be the highest of all of the three options considered at stage three. The coefficients for the internet and call centre of -0.030 and -0.012, demonstrate that at the third stage respondents derive a greater benefit from the internet over a call centre in relation to wait-time saved. The cost coefficients at the third stage show that SMS was estimated to have the lowest negative cost coefficient of -0.21 (see model M3, table 4). The cost coefficients found the call centre to have the second lowest value (-0.039) and the internet to have the third (-0.071). These results show that the disutility of paying for real-time information is lowest with the SMS option, indicating that respondents are willing to pay for transit information from an SMS.

The type of information variables estimated at stage three were shown to be negative and significant at the 99% confidence level (see model M3, table 4). The SMS coefficient was estimated to have the highest value of -1.221, followed by the call centre (-0.814) and the internet (-0.439). These results demonstrate that respondents derive the greatest benefit from receiving real-time information from an SMS at the third stage. Based upon the coefficients for wait-time saved, cost and type of information it is fair to say at the third stage respondents derive the greatest benefit from using an SMS to receive real-time information.

Variables		***M1***	***M2***	***M3***
		Stage One	**Stage Two**	**Stage Three**
Internet	Wait-time saved	-0.040 (-5.6)**		-0.022 (-3.5)**
	Cost	-0.040 (-5.5)**		-0.051 (-13.6)**
	Information	-0.852 (-3.1)**		-0.514 (-7.6)**
SMS	Wait-time saved	-0.042 (-5.4)**	-0.032 (-4.3)**	-0.024 (-3.4)**
	Cost	-0.035 (-12.9)**	-0.044 (-6.1)**	-0.044 (-7.6)**
	Information	-0.997 (-10.4)**	-0.879 (-7.3)**	-1.109 (-7.2)**
Call centre	Wait-time saved	-0.032 (-4.9)**	-0.017 (-2.6)**	-0.015 (-8.3)**
	Cost	-0.039 (-9.2)**	-0.068 (-7.6)**	-0.037 (-8.7)**
	Information	-0.377 (-2.5)**	-0.710 (-7.2)**	-0.782 (-7.9)**
PID	Time saved		-0.043 (-7.1)**	
	Cost		-0.040 (-9.6)**	
	Information		-0.947 (-7.8)**	
N		1980	1980	1980
ρ^2 *(0)*		0.251	0.225	0.228
ρ^2 *(c)*		0.207	0.211	0.217
Final Likelihood		-1714.21	-1701.14	-1749.51

* Significant at the 95% confidence level
** Significant at the 99% confidence level

Table 4, MNL Model Estimates

7. CONCLUSIONS

At the first stage of a transit trip, individuals were found to derive the greatest utility from using an SMS, followed by the internet and a call centre. At the second stage of the options considered, respondents indicated that they would derive the greatest benefit from a PID; this is seen in the MNL model estimates.

At the second stage of the options considered, respondents indicated that they would derive the greatest benefit from a PID. A PID is the most convenient and easily accessible option while respondents wait at their stop/station as passengers are not required to use any information technology. The SMS option was found to produce the second highest coefficient values, followed by the call centre option. Once again this result may be a product of the convenience and speed of accessing an SMS compared to a call centre.

At the pre-trip planning stage from work returning home, respondents indicated that they would derive the greatest benefit from using an SMS, followed by a call centre and the internet. These findings demonstrate at this stage respondents derive the greatest benefit from using an SMS. As with the first stage this finding may be related to the convenience associated with using this method of real-time information compared to the other options considered at this stage.

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