Impact of Bus Priority Attributes on Catchment Area Residents in Dublin, Ireland

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Abstract

In many jurisdictions, political and infrastructural restrictions have limited the feasibility of road pricing as a response to urban congestion. Accordingly, the allocation of dedicated road space to high frequency buses has emerged as a second-best option. Analyses of the evidence emerging from this option emphasize the engineering and technical issues and do not systematically interrogate the customers, those in the bus catchment area that use or could potentially use the service. This paper attempts to correct for this asymmetry in focus by analyzing characteristics and preferences of users and non-users through a survey of 1,000 households for a particular quality bus catchment area in Dublin, Ireland. Preliminary findings are encouraging, both for the use of this policy instrument as one which can yield considerable consumer satisfaction, and in terms of modal share analysis, especially because the corridor under scrutiny represents a much higher socio-economic profile than Dublin or Ireland as a whole.

Introduction

Bus priority applications¹ as a policy response to road congestion have a long history, going back to the 1930s, but it is in the last two or three decades that bus

priority measures have become a central element in tackling the externalities associated with increased urban road use.

Studies related to bus priority have explored a wide degree of topics (see, for example, Polus 1978, Bokinge and Hasselström 1980, Balke, Dudek and Urbanik 2000). However, as the Transportation Research Board (2003) notes, the focus has been on mechanical and engineering issues, and performance of bus priority measures has typically been assessed using the numbers of passengers carried and the travel speeds of the vehicles. In contrast, the individual preferences of bus users and potential users within the context of transport choice have received relatively little academic focus. As Wardman (2001) notes, valuations of a wide range of public transport travel and service quality attributes have not received the level of attention that they warrant. Moreover, within the literature investigating individual preferences, relatively little attention has centred on the attitudes and underlying factors influencing the behavior of the population of most likely users, i.e., those living within the catchment area of such bus priority measures. Authors such as Hensher et al. (2003) and Baltes (2003) assess the impact of attributes on present bus users through the provision of on-bus surveys. This paper extends these studies by assessing the impacts on modal choice for the population living in the catchment area of a corridor with bus priority measures—both bus users and non-users.

The motivation of this paper is to address this issue, and the focus is threefold. First, it aims to cover a gap in an under-researched area of public transport by investigating the perceptions, attitudes and behavior characteristics of 1,000 respondents living in a Geographic Information Systems (GIS) constructed catchment area. Second, we analyse the determinants of modal choice which impact users and potential users—this is particularly interesting given that the catchment population under investigation has an educational and socio-demographic profile that is higher than either the Dublin or Irish average and, therefore, would be regarded *a priori* as a relatively difficult group to “get out of their cars.” Finally, differences in the perceptions of bus-specific attributes, based on bus usage, were tested.

The Quality Bus Corridor (QBC) analyzed, the N11 QBC running from Dublin City Centre through South East Dublin City and County (see Appendix 1 for a map), has experienced rapid growth in passenger numbers since its upgrade in 1999. Despite a widespread view by both policymakers and the public at large that the

corridor has been a success, there has been a lack of research to confirm this perception.

The outline of this paper is as follows; the next section outlines some key literature relating to bus priority. Section 3 outlines the policy responses to traffic congestion in Dublin. Using the survey data collected in the catchment area of the QBC under investigation, Section 4 investigates the modal share, performance and user attitudes. Section 5, through the use of probit analysis, identifies the key factors influencing bus usage along the QBC. Section 6 assesses how the perceptions of 9 bus-specific attributes vary across bus users and non-bus users. Section 7 concludes.

Literature Review

Traffic congestion is one of the most contentious urban issues facing policymakers today, and the associated costs can be high.² In Dublin there has been reluctance on the part of policymakers to implement 'push' pricing policies (shifting car users to other modes through increasing the average cost of a car trip) and, despite longer term proposals to increase the attractiveness of public transport in the city (i.e., light rail transit or metro options), continued urban congestion has demanded more immediate and flexible policy responses. It is in this context that bus priority measures have become one of the major instruments used by policymakers to affect modal shift.

The use of buses to provide rapid transit is, however, far from a new concept. Proposals for such measures go back to the 1930s (for an extensive review, see the Transportation Research Board 2003a). Despite its long history, a clear definition of Bus Rapid Transit remains, as the Transportation Research Board (2003a) notes, elusive. It is seen to include bus services that are, at a minimum, faster than traditional "local bus" services and that, at a maximum, include grade-separated bus operations.

Engineering and implementation issues arising from bus priority schemes are a well-researched topic. The Transportation Research Board (2003a, 2003b) has set out implementation guidelines for researchers and practitioners in the U.S. Similarly, the UK Department for Transport (DETR 2004) has set out implementation best practices. Authors such as Wardman (2000) and Horn (2002) analyze service improvements and passenger transport performance. In Ireland, Caulfield and

O'Mahony (2004) measure performance by assessing level of service attributes such as headway, transit/auto comparison and service coverage.

Despite the variety of topics investigated by researchers, there is relatively little focus on the impact of bus priority measures on the urban transport consumer. Recently, bus priority measures have started being assessed in the wider context of modal and route choice. Rodríguez (2002) investigates bus dwell times in a competitive busway. Alpizar and Carlsson (2003) assess a policy of improving bus attractiveness in San José, Costa Rica, to those already commuting by car and note a state dependence variable which captures the reluctance of existing car users to switch. This is in the same line as previous studies (Bhat 1998; Swait and Eskeland 1995, Asensio 2002). Hensher and Reyes (2000) also identify car availability as a significant barrier to public transport use in the context of trip complexity. O'Fallon et al. (2004) identify actions such as transporting children and off-peak mobility requirements as barriers.

Friman (2004) also assesses customer satisfaction with quality improvements in public transport. Currie (2005) adopts a trip attribute approach to compare the passenger attractions of BRT relative to other public transport modes and finds that rail holds an advantage over normal on-street bus services but that, in general, no such advantage exists over BRT.

Hensher et al. (2003) and Prioni and Hensher (2000) have investigated service quality management through the use of on-bus surveys to assess the impact of 13 attributes on bus customer satisfaction. This research focuses on the ability to compare quality levels within and between bus operators but does not specifically deal with the issue of bus priority. Baltes (2003) does investigate service attributes related to bus priority. Comfort and travel time attributes were seen amongst the most important by existing users of the service. In the context of experimentation connecting consumer attitudes to behaviour, Parkany et al. (2004) outline recent transportation-related attitudinal data applications. However, none of these studies investigates attitudes of catchment area respondents to bus priority attributes.

As far as the authors are aware, where the impact of bus attributes has been investigated, (i.e., Hensher et al. 2003; Baltes 2003), it has tended to focus on wider modal choice issues or be restricted to existing bus users. These investigations do not capture the perceptions of attribute importance of non-bus users (among them, potential users). Moreover, the use of bus-surveys introduces an additional restriction, namely, the limited time available to survey each respondent, reduc-

ing the ability to capture background information such as socio-economic and demographic characteristics. Our research, investigating survey data of 1,000 residents in a catchment area of a bus priority scheme, assesses the views of transport consumers—both bus and non-bus users. In this way, influences on modal choice for those most likely to use the bus priority corridor—catchment area residents—are interrogated.

The N11 Quality Bus Corridor and Catchment Area

Infrastructural Context

As the capital of one of the fastest growing economies in the developed world since the mid-1990s, Dublin has faced major infrastructural bottlenecks. Associated with the rapid economic growth has been a rapid growth in private car ownership, which in turn has resulted, due to inadequacies in public transport, in increased car-commuting and increasing congestion in the Greater Dublin Area (GDA).³

Despite early attempts at introducing Bus Priority in Dublin (see, for example, CIE 1984), the primary policy driver for change in Dublin has been the Dublin Transportation Initiative strategy (DTI 1995). As part of this, an ambitious program of dedicated bus corridors has been mapped out and partially implemented.⁴ This has spurred an interest in “reinventing” buses, through bus priority measures, as an important contribution to solving the congestion and externality problem associated with private-car use.

The bus market in Dublin is a state-owned monopoly. Although a number of small operators carry passengers from outside the city, the vast majority of scheduled bus journeys were made on *Bus Atha Cliath*—Dublin Bus.

This paper focuses on the N11 QBC, which runs from Dublin City Centre through south eastern suburbs along the route of the N11 Road, a main arterial route into the city. The route was upgraded to a quality bus corridor in 1999 (see Appendix 1 for a map of the QBC and its catchment area). For most of the route, the corridor is segregated from general traffic.⁵

Table 1 is based on results from the 2004 annual traffic count by the Dublin Transportation Office (DTO 2005) and indicates the comparable journey times for bus and car for the stretch of the N11 Road from Foxrock Church to Leeson Street in the City Centre. The table indicates the minimum and maximum recorded times

of the bus and the car on this route. For instance, for AM Peak Inbound, the quickest bus time recorded was 20'24" (20 minutes and 24 seconds) and the slowest is 34'12" (34 minutes and 12 seconds). The DTO carries out traffic counts and reports the ranges of recorded bus times.⁶

Table 1. Bus and Car Journey Times, November 2004 (Range)

Time of Travel	BUS Recorded Journey Times		CAR Recorded Journey Times	
	Minimum	Maximum	Minimum	Maximum
AM Peak Inbound*	20'24"	34'12"	15'49"	47'41"
Off Peak Inbound*	24'32"	28'28"	14'05"	23'53"
PM Peak Outbound*	20'46"	34'15"	-	-

Notes: 1. Based on journeys from Foxrock Church to Leeson Street in the City Centre (See Appendix 1 for a map)
2. Minimum refers to minimum DTO recorded journey time for bus and car on this route, maximum is the highest recorded journey time.

Variability in journey times is far lower for the bus than for the car on this route and peak bus journey times can be considerably quicker. The modal share of the bus along the corridor has increased by 239 percent between 1997 and 2003 (representing a modal share of 46.76%). Over that same period, the modal share of the car along the route has fallen by over 40 percent to 29.10 percent (DTO 2004). In comparison, the Dublin area has a bus modal share of less than 20 percent (CSO 2004b).

The N11 QBC is not the best performing QBC in the city in terms of relative journey times or modal share; however, when looking at passenger growth between 1997 and 2004, the N11 QBC has recorded, by far, the strongest growth amongst all QBC's. In addition, the socio-demographic and education profile are higher than for either the Dublin or Irish average. This makes it an interesting case study.

The N11 QBC Catchment Area

For the purpose of this research, a survey was carried out over a sample population drawn from residents in the catchment area of the N11 QBC. As a passenger can generally access the bus service only at a bus stop, the catchment area radius was centered on each bus stop itself. Each bus stop along the corridor was mapped using GIS technology. A buffer zone centred on each bus stop was created using data inputted into *Arcview*. Murray et al. (1998) and Murray (2001) have sug-

gested and tested a catchment area of 400 metres (or $\frac{1}{4}$ of a mile) from each bus stop for bus travel, but 800 metres was chosen instead.⁷ In the model used by the DTO, it is assumed that a 10-minute walking distance (or 800 metres) is a typical reasonable distance for QBC commuters (at a walking speed of 5 km/h). Using census data, 31,556 residential addresses (corresponding to a population of 87,936 persons) were identified in the catchment area.⁸ It is from this population that the sample population for the survey is drawn.

The sample population has a higher proportion of respondents falling into the upper socioeconomic categories and are either the Dublin or the national average; nearly two fifths of this sample have a 3rd level degree or higher compared a quarter of the general Dublin population (CSO 2004a).

Modal Share and Performance on the N11 Quality Bus Corridor

Modal Share and General Travel Characteristics of Sample Population

The survey of catchment area residents was conducted in summer 2005. Respondents were interviewed in their home, face-to-face, by a survey company and each interview lasted approximately 20 minutes. The survey included questions relating to the sample population demographic and transport characteristics and their attitudes to bus travel and the N11 QBC. The survey population was representative in terms of gender and age breakdown of the catchment area population and was restricted to those residents between 13 and 75.

Over 87 percent of the sample travelled along the N11 Road by any means of transport at least once a week. The proportion of respondents who report themselves as “bus users” and “non-bus users” is outlined in Table 2. A total of 41.80 percent are bus users and, of the remaining 58.20 percent non users, car users account for 51.10 percent of the sample.

The N11 is the primary commuting artery for the vast majority of sample (almost 80% of respondents cite one or two members of their household using it). Bus and car users are disproportionately represented in the survey sample, compared to the general Census trends. The proximity of the sample to a main commuter artery and the QBC may explain a large part of this.

In terms of frequency of N11 use, a majority of those who travelled 5 days a week or more on this road, used the car while 37 percent travelled by Dublin Bus. Dublin

Table 2. What mode of transport do respondents primarily use along the N11?

Mode	Percentage		
Dublin Bus on QBC	41.40	Bus Users: 41.80	BUS USERS: 41.80
Other Bus on QBC	0.40		
Private Car Unshared	40.30	Car Users: 51.10	NON BUS USERS: 58.20
Private Car Shared	10.80		
Motorbike	0.80	Other Modes: 7.10	
Taxi/Hackney	0.40		
Walk	2.10		
Bicycle	3.80		

Bus is the most popular mode of transport for those who use the road between 1 and 4 days a week. In terms of destination, almost 44 percent of the sample gave the city center as their primary destination when travelling along the N11. The spread of destinations is wider, the further from the city center the respondent's origin is. Only 10 percent of the sample made an intermediate stop with car drivers being most likely to be stopping. Almost 50 percent of those stopping did so for leisure reasons or for shopping.

Bus users account for a third of the 5-day-a-week commuters. Bus users are also more likely to restrict their use of the N11 to the rush hours with half of all bus users who travel northbound using it in the morning rush hour, compared with only one third of the car users. A majority of bus users cite the city centre as their primary destination.

Car users are the most frequent users of the N11 and have travel times and destinations that are more varied than other modes. Of car users who switch to other modes on occasion (almost 50%), a higher proportion of car sharers than solo car drivers switch. Females are also more likely to switch modes. A total of 60 percent of car users who switched either had problems with parking or wished to drink alcohol (with younger males more likely to cite the latter).

Most Realistic Options and Fastest Modes

Half of respondents cited the car, either as driver or passenger, as their most realistic transport option, followed by the bus at 40 percent (with a close correlation between this and a respondent's reported modal choice). Two fifths of bus users

cite being a car passenger as their second option, a quarter would drive. Car drivers would switch to being a car passenger (60%) followed by the bus (at 30%). Of car sharers, almost 70 percent view the bus as the next option; fewer than 20 percent would switch to driving.

The bus is perceived as the fastest peak-hour mode along the corridor by all socio-economic, geographical, transport and demographic groups. However, this trend is reversed for travel in off-peak periods, with no group citing the bus as the fastest mode in these time periods.⁹ All respondents show overwhelming support for the retention of the QBC—despite a perception, especially among car users, that traffic levels have increased moderately or significantly.

Determinants of Modal Choice along the N11 Road

Bus Users: What Factors have the Biggest Impact on Usage?

The sample was separated into bus and non bus users. Self-reported bus users were asked to identify the factors that have the biggest impact on their decision to use the bus. In total, 62 percent cite lack of car availability as a reason for using the bus.¹⁰ These users are thus not “choice” riders in the sense that they have less flexibility in their travel behaviour than respondents with access to a car. The next three factors are bus “pull” factors (i.e., the quality/proximity of the bus apropos other modes): bus reliability/congestion, presence of a nearby bus stop and presence of a QBC along the route. Nearly a quarter of bus users cite either one or both of the latter two factors.

Non-Bus Users: What Factors have the Biggest Impact on Not Using the Bus?

Users of all other modes (mostly car users) were asked about their motivations for not using the bus.¹¹ Almost 60 percent of this group cited the availability of a car as a reason for not using the bus; 18 percent of non-bus users cite push factors such as the quality of public transport in terms of reliability and comfort.¹² A total of 13 percent of non-bus users said that they did not use the bus because they either made multiple stops or had children with them (all of the latter were female), 9 percent view other modes as faster than the bus and one in seven mentioned the availability of parking facilities.

Table 3. Reasons for Using the Bus on the N11

Factor	Total Responses #	% of Bus Users Citing Factor
No Car Available	262	62%
Traffic Congestion- Bus Most Reliable	69	16.51%
Presence of a Bus Stop Nearby	58	13.88%
Presence of a QBC Along the Route	58	13.88%
Lack of Parking Facilities	44	10.63%
No Other Suitable Public Transport Available	37	8.85%
Cost of using Car Exceeds Public Transport	31	7.42%
Ease of Transfer to Other Public Transport	18	4.31%
Quality of Waiting and On-Bus Facilities	12	2.88%
Environmental Concerns	11	2.63%
Other	23	5.50%
Don't Know	7	1.68%
Total Responses:	630	-
Total Number of Respondents	418	-

Note: Percentages do not add up to 100 as respondents could cite more than one factor.

Determinants of Modal Choice along the N11 Quality Bus Corridor

Probit regression analysis was also conducted to determine the impact of socio-demographic and travel characteristics of the respondents on the probability of bus usage along the N11. The dependent variable is a binary variable which takes the value of 1 if the respondent is a self-reported bus user and zero otherwise. Appendix 2 describes the independent variables that were included in the probit analysis.

Model 1: Demographic and Basic Transport Influences on Bus Usage:

Table 5 (columns 2 and 3) outlines the results of a probit regression explaining the factors influencing bus usage in our sample.¹³ As expected, the coefficient on household income is negative and significant (at the 5% level) indicating that, as household income increases, the probability of being a bus user declines. This relationship is, however, very weak, possibly due to the fact that the population under investigation has a high socio-economic profile. Full or part-time employment reduces the probability of being a bus user by 16 percent and 10 percent respectively (in relation to those who are not working). The direction of this rela-

Table 4. Factors for Not Using the Bus on the N11

Factor	Car Solo	Car Shared	M'bike walk	Taxi	Bike/	Total	% Citing Factor
Availability of Car	259	72	0	2	7	340	58.42%
Parking Available at Destination	65	16	1	0	0	82	14.09%
Public Transport Unreliable	55	16	2	0	6	79	13.57%
Poor Connections	41	7	1	0	3	52	8.94%
Car/Other Mode is Faster	33	13	2	1	2	51	8.76%
I have Children With Me	34	12	0	0	2	48	8.25%
I use Non-Motorised Mode	5	2	0	0	39	46	7.90%
Do Not like Public Transport	31	6	1	0	6	44	7.56%
Comfort/Pub. Transport Unpleasant	31	7	0	0	2	40	6.87%
Make Multiple Stops on Journey	32	6	0	0	0	38	6.53%
Bus Doesn't Run When I Need it	20	6	0	0	1	27	4.64%
Cost of Using Car not Prohibitive	20	3	0	0	1	24	4.12%
Public Transport Cost	12	2	0	0	7	21	3.61%
Other Public Transport Availability	11	7	0	0	0	18	3.09%
Poor Waiting Facilities	12	2	0	0	1	15	2.58%
Poor Public Transport Information	11	3	0	0	1	15	2.58%
Personal Disability	8	3	0	0	0	11	1.89%
Other	51	23	4	1	8	87	14.95%
Don't Know	34	6	0	0	7	47	8.10%
Total Responses	765	212	11	4	93	1085	-
Total Number of Respondents	403	108	8	4	59	582	-

Note: Percentages do not add up to 100 as respondents could cite more than one factor.

tionship is repeated for those having a mortgage and living rent free (relative to owner occupiers). Those who travel on the N11 3-4 days a week or less than once a week are also more likely to be bus users than those using the N11 5 or more days a week.

Table 5. Marginal Effects of Probit for Impacts on Bus Usage on the N11

Operation: Dep Variables: → Exp Variables: ↓	Model 1: Impacts on N11 Bus Usage (dy/dx) N11bususers		Model 2: Impacts on N11 Bus Usage (Car Availability and Location – dy/dx) N11bususers	
Hseincome	-1.55 e-06**	(.0000)	-1.54e -06**	(.0000)
Empfull	-.1652 ***	(.0406)	-.1683 ***	(.0420)
Emppart	-.1014 *	(.0557)	-.0878	(.0573)
Hsemort	-.1107 **	(.0433)	-.1046 **	(.0449)
Hserent	-.0327	(.0544)	-.0196	(.0566)
Hserentfree	-.1148*	(.0698)	-.0986	(.0733)
Hsesocial	-.1246	(.1677)	-.0340	(.1981)
Hselength2_5	.0260	(.0624)	.0708	(.0656)
Hselength6_10	.0238	(.0681)	.0425	(.0705)
Hselengthover10	.0405*	(.0648)	.1169	(.0678)
Edstud	.0487	(.0810)	.0443	(.0842)
Ed2nd	.0085	(.0657)	.0280	(.0683)
Ed3rd	-.0331	(.0694)	-.0055	(.0730)
Age	-.0805 ***	(.0130)	-.0812 ***	(.0135)
Male	-.0858 **	(.0344)	-.1011 ***	(.0356)
Child14_18	-.000 3	(.0506)	-.0200	(.0519)
Child6_13	-.1079 **	(.0508)	-.0985 *	(.0526)
Childunder5	-.1201 *	(.0632)	-.0771	(.0675)
Hhn11users	-.0155	(.0172)	-.0175	(.0182)
N11freqless	.1273 **	(.0591)	.2018 **	(.0617)
N11freq1_2	.0530	(.0487)	.0562	(.0507)
N11freq3_4	.0923 *	(.0499)	.1021 **	(.0524)
N11timesthvar	-.0619	(.0602)	-.0944	(.0612)
N11timenthvar	-.1381 **	(.0603)	-.1107 **	(.0630)
N11intermedtotal	-.2861 ***	(.0445)	-.2516 ***	(.0512)
availablecar	-	-	-.3312 ***	(.0385)
Luas	-	-	-.1644**	(.0667)
Dart	-	-	-.0119	(.0523)
Extension	-	-	-.1780	(.0385)
Pseudo R2		0.1312		0.2049
N		1000		1000

Notes: 1. Standard Errors in brackets constructed using the White-Heteroskedasticity-Consistent Variance-Covariance Matrix.

2. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

3. dy/dx is for discrete change of dummy variable from 0 to 1.

Increasing age and being a male both reduce the probability of bus usage by approximately 8 percent. As we would expect from the analysis of the descriptive statistics, having a variable northbound commuting time and having children under 13 decreases the probability of bus usage. Those making an intermediate stop are 28 percent less likely to be bus users (the strongest reported relationship).

Model 2: The Impact of Car Availability and Location Impacts on Bus Usage

In model 2 (columns 4 and 5), new dummy variables are introduced to the model. These include car availability,¹⁴ presence of a light rail (Luas) and heavy rail (Dart) station close to respondent origin, and, finally, whether the respondent lives beyond the Foxrock turnoff (where many services turn off the QBC; accordingly, bus frequency is reduced for commuters beyond this point). Car availability emerges as a significant variable explaining the probability of being a bus user on the N11 Road. Having a car available reduces the probability that respondents will be a bus user by 33 percent. This is a widely reported relationship. Previous studies, e.g., Hensher and Reyes (2000) and Alpizar and Carlsson (2003), have shown the importance of having a car and the inertias it generates on modal choice, i.e. the reluctance of those already using the car to switch to other modes. Looking at the other new explanatory variables, shows that while the presence of a heavy rail station within the catchment area of a respondent has no significant impact on bus usage; living near a Luas light rail station reduces the probability of being a bus user by 16 percent. This reinforces the findings of the DTO (DTO 2005) that the introduction of a light rail line in summer 2004 has impacted on patronage along the N11 QBC and is a significant finding of this research for policymakers in Dublin and elsewhere. The remaining results of Model 2 largely mirror the previous model, and mirror the findings of Hensher and Reyes (2000) for Sydney, which showed that income, age, full time employment, the availability of a car in the household, and the presence of more complicated trips (i.e., intermediate stops) act as barriers to public transport usage. The results are broadly comparable, this despite our sample population having a higher than average demographic profile.

Determinants on Bus usage—Importance of Bus Attributes to Respondents

Respondents were asked to rate the importance of nine attributes of a bus journey along the N11. These nine attributes (peak journey times, off-peak journey times, cost, seat availability, bus stop facilities, real time information, ticket machines at

bus stops, park and ride and priority for buses at junctions) were selected after two focus group based discussions with catchment area residents. Interestingly, attributes, such as security, given importance by other researchers (e.g., Baltes, 2003), were not considered an important determinant by residents; thus, they were omitted from the analysis. This, again, may be due to the socio-economic make up of the area under investigation. The results are set out in Figure 1.

Figure 1. Importance Rating of Attributes of Bus Use

Journey times emerge as the most important attribute for the sample with peak journey times slightly outweighing off-peak journey times. Cost is also an important attribute. Interestingly, more priority at traffic junctions for buses was considered the least important attribute, which given the potential journey time savings, may seem paradoxical. However, when this attribute was presented at focus groups, the concept in itself was controversial. Most participants were unfamiliar with the concept (no such system presently exists in Dublin) and many were hostile, assuming that it would impact negatively on all traffic. Unfamiliarity may explain some of this contradiction.

Impact of Modal Choice on Perceptions of Attribute Importance

When the difference in importance placed on different attributes across groups was analyzed, we found different patterns between bus users and users of other modes. We would expect that bus users who have frequent and first hand experience of the bus services would have different perceptions of the importance of bus-specific attributes than infrequent or non-users. To see if being a bus user impacted significantly on attribute perceptions, after controlling for other factors such as socio-economic and transport characteristics further probit analysis was conducted in which the probability of stating an attribute as important was explained, among other variables, by modal choice.¹⁵

Nine variables were created, which captured the importance of the 9 attributes of a bus journey to respondents. These binary variables took the form of 1 if the attribute was considered important and 0 otherwise.¹⁶ The influence we are investigating is the impact of being a bus user on the perceptions of the nine bus attributes, after controlling for the other socio-economic and transport-related characteristics (those included in Model 2 of Section 5).

Column 2 of Table 6 indicates the statistical significance and the direction of the relationship and the degree of influence that bus usage has on the attribute perceptions. These estimates come from 9 different probit regressions.¹⁷

Table 6. Bus Usage and Attribute Perceptions: Marginal Effects of Probit

Attribute (Dependent Variable):	Bus Usage Influence on Attribute Perception (dy/dx):	Standard Error
On-Peak Bus Journey Times	.1325***	.0242
Off-Peak Bus Journey Times	.1561***	.0285
Bus Cost	.1142***	.0324
Seat Availability	.2039***	.0318
Bus Stop Facilities	.1988***	.0331
Real Time Information	.0153	.0358
Ticket Machines at Bus Stops	-.0206	.0370
Park and Ride Facilities	-.0274	.0375
More Priority for Buses at Junctions	.0986***	.0368

- Notes: 1. dy/dx is for discrete change of dummy variable from 0 to 1.
2. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.
3. All 9 probit regressions included socio-economic and transport related characteristics as explanatory variables (not reported).

According to Table 6, bus usage has a significant impact on the perception of six of the nine attributes so that those who use the bus have different perceptions of the attributes than users of other modes. For all six attributes where there is a significant difference in perceptions of the attributes, the relationship is positive. This indicates that bus usage increases the probability that respondents place importance on these attributes.

Being a bus user results in a 13 percent increased probability in placing importance on peak bus journey times and 16 percent increased probability in placing importance on off-peak bus journey times. Bus usage has the biggest impact on seat availability and bus stop facilities (20.3% and 19.9% increases in importance, respectively). The probability of placing importance on bus cost is increased by 11 percent by being a bus user. The weakest significant influence is for an increase bus priority at traffic junctions.

The results that bus users place more importance on these characteristics is not surprising, since, unlike car users, it is bus-users who experience varying levels along these six attributes on a frequent basis. Moreover, there is no significant difference between bus users and users of other modes for the three remaining attributes. This may be a result of the fact that these attributes are not presently available on the route. Respondents are either unfamiliar with the attributes or simply, the views of both groups do not differ in relation to these three attributes.

To capture the potential difference in perception between “choice” and “captive” bus users (i.e., those without the availability of alternative motorised transport), we repeated the nine probit regressions including an additional variable that captured the interaction effect between bus users and car availability.¹⁸ In seven cases, this variable was insignificant, indicating no differences between the perceptions of “choice” and “captive” bus user regarding bus-journey attributes. Interestingly, we found a significant difference between both groups regarding bus stop and park-and-ride facilities. This can be explained by “choice” bus users being able to avail of park-and-ride facilities to combine car use and bus use on the corridor.

Conclusions

As noted at the outset of this paper, bus priority measures have typically been assessed using engineering and revealed preference techniques (i.e., the number of passengers carried and the travel speeds of the vehicles). Studies that have investigated individual preferences and perceptions have tended to do so in the context

of wider modal choice models, or through analysing the impact of attributes to those already using the bus mode (e.g., Hensher et al. 2003, Baltes 2003). An additional downside of on-bus surveys is the restrictive time available to investigate wider issues such as the socio-demographic profile of the respondent.

This paper aims to cover a gap in an under-researched area of public transport by investigating the perceptions, attitudes and behaviour characteristics (as well as demographic characteristics) of 1000 respondents, comprising current users and potential users, living in the GIS constructed catchment area. The findings of our research demonstrate that it is possible, in a relatively high-income urban catchment, to provide a bus option that attracts over 40 percent of the commuter traffic, the key to this success being mainly shorter journey times at traffic peaks. However, it is also clear that for the remaining passengers—notably the car users—there are challenges in improving this ratio.

The descriptive statistics and probit analysis have highlighted influences on modal choice. As evidenced by previous studies, variables decreasing the probability of being a bus user include demographic features such as income, age, employment status and the presence of children in the household. We have also found that while the bus is perceived as the fastest mode in peak periods, its advantage diminishes significantly for the off-peak period. This perception is especially strong for car users and the loss of its journey time advantage indicates an additional barrier to public transport usage amongst car users on this corridor. Interestingly, this research has confirmed perceptions that light rail has acted as a substitute to bus priority for those living close to a light rail station—a particularly relevant finding for policymakers and researchers interested in such a relationship.

This study has also assessed the importance of modal choice on the perceptions of nine bus specific attributes. Results indicate that attributes and their importance are viewed differently by users of different modes. Being a bus user is likely to increase the probability of placing importance on the bus-journey attributes with which bus users have familiarity through frequent use.

This may also indicate that, for many car users, these attributes are considered as important only in the context of bus use and are not central to their decision making process. The primary determinant in the use of the bus is the availability of a car to the respondent. For both bus using and non-bus using respondents, the availability or otherwise of a car is the most cited factor. The probit analysis reinforces this finding. For car users specifically, the inertia effect—the reluctance of those already using the car to switch to alternative modes—discussed by Alpizar

and Carlsson (2003) has been identified as the biggest single barrier to bus use on this corridor for those not already using the mode.

Since the proportion of households and commuters with access to a car is likely to increase in the future, the challenge of getting “choice” riders—those of relatively high income with a car—to switch or to continue to use the bus will intensify. Our analysis does give indications as to what policy changes are likely to be relevant. Availability of parking is the second most important reason given by respondents for choosing the car over the bus, and our analysis confirms that for “choice” bus users it is a more important factor than for “captive” bus users. Policy can restrict parking availability or make it more expensive. The perceptions that public transport is unreliable and slower are other areas where positive intervention would help. As of April 2006, passengers get on and off at the same door, leading to congestion, and many passengers pay cash, both of which increase the time delays at stops. These inefficiencies slow journey times, and both could be changed, and this in turn would increase the attractiveness of this option to “choice” riders.

Endnotes

¹ In this paper, we refer to “bus priority measures” as elements of Bus Rapid Transit (BRT) that have been implemented in Dublin, the area of study. The primary measures include grade-separated right-of-way, frequent, high-capacity services, high-quality vehicles, improved rider information. For more, see DTO (2005).

² A special advisory group to the European Union note an estimate for congestion at 2% of GDP per annum (Nash and Samsom, 1999).

³ Private car ownership in the GDA during the past decade has almost doubled (DTO 2002). AM peak hour travel demand increased by 65% and is expected to almost double again by 2016 (DTO 2000).

⁴ From an interview with the Quality Bus Network Office: Approximately 120km of bus priority have been developed, and there is a potential for up to 400km to be developed.

⁵ As of November 2004, 86% of this section was segregated from general traffic (DTO 2005).

⁶ Unfortunately, averages of these ranges are not provided as part of the reporting process. For more, see DTO (2005).

⁷ After consultation with Dublin Bus and the Dublin Transportation Office, it was decided that a 400 m. limit was too conservative. Similarly, Bacon (1998) suggests a wider (500m) QBC catchment area.

⁸ 5,961 of these addresses are in the 12 Dublin City Council electoral districts and 25,595 in the 38 Dun Laoghaire Rathdown electoral districts

⁹ In the peak period, bus users consider the bus to be the fastest mode, 36% of solo car users also hold this view, compared with less than 30% who opt for the car. However, in off-peak performance, fewer than 50% of bus users view the bus as the fastest mode. Two thirds of car drivers opt for the car (with only 9% viewing the bus as the fastest mode in the off-peak).

¹⁰ Ranging from about 70% for those under 24 to fewer than 50% for those 35-44. Less than 50% of those in the highest socioeconomic class cite this reason compared to 70% of those in the lowest class.

¹¹ 87% of this group identify themselves as car users, of which four fifths are solo car drivers.

¹² Reliability is far more likely to be mentioned by those who are younger.

¹³ Results shown indicate marginal effects analysis of probit regressions.

¹⁴ The survey did not ask a direct question on whether the respondent had access to a car. Thus, the dummy variable for car availability takes the value of one for present car users and bus users who do not cite lack of car availability as a determinant for bus use.

¹⁵ There is a potential issue of endogeneity with modal choice being explained by the importance of the characteristics. However, when these variables were included as regressors in Table 5 they were not significant. In addition, while authors such as Hensher et al. (2003) and Baltes (2003) have assessed the importance of attributes to bus users, we are investigating the influence of these attributes to a wider population and thus, how users of different modes view attributes is of central importance.

¹⁶ "Important" was assigned for respondents who considered a bus attribute "important" or "very important."

¹⁷ Results for other explanatory variables in the regressions are available from the authors upon request.

¹⁸We would like to thank an anonymous referee for suggesting this effect. Results from these additional regressions are not reported in the paper but are available from the authors upon request.

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Appendix 1. Route of N11 QBC and 800 metre Catchment Area

Appendix 2. Variables Used in Probit Regressions

N11Bususer	Dummy variable for modal use on N11 (1=bus user, 0= otherwise)
Hseincome	Self reported household income (with proxy for non-answers)
Empfull	Dummy variable for employment status (1= full time, 0=otherwise)
Emppart	Dummy variable for employment status (1=part time, 0 =otherwise)
Empnot	Dummy variable for employment status (1=other working status, 0=otherwise)
N11freq5	Dummy variable for frequency of N11 use (1=5 times a week, 0=otherwise)
N11freq3_4	Dummy variable for frequency of N11 use (1=3/4 times a week, 0=otherwise)
N11freq1_2	Dummy variable for frequency of N11 use (1=1/2 times a week, 0=otherwise)
N11freqless	Dummy variable for frequency of N11 use (1=less than once a week, 0=otherwise)
Hseown	Dummy variable for House tenure type (1=own outright, 0=otherwise)
Hsemort	Dummy variable for House tenure type (1=mortgage, 0=otherwise)
Hserent	Dummy variable for House tenure type (1=rent, 0=otherwise)
hserentfree	Dummy variable for House tenure type (1=live rent free, 0=otherwise)
Hsesocial	Dummy variable for House tenure type (1=social housing, 0=otherwise)
Hselength0_1	Dummy variable for House length (1=one year or under, 0=otherwise)
Hselength2_5	Dummy variable for House length (1=two to five years, 0=otherwise)
Hselength6_10	Dummy variable for House length (1=six to ten years, 0=otherwise)
Hselengthover10	Dummy variable for House tenure type (1=over ten years, 0=otherwise)
Edprime	Dummy variable for education attainment level (1=primary or below, 0=otherwise)
Edstud	Dummy variable: education attainment level (1=second/third level student, 0=otherwise)
Ed2nd	Dummy variable for education attainment level (1=secondary level, 0=otherwise)
Ed3rd	Dummy variable for education attainment level (1=third or post third level, 0=otherwise)
Age	Variable: age respondents (1=13-18, 2=19-24, 3=25-34, 4=35-44, 5=45-54, 6=55-64, 7=65-74)
Male	Dummy variable for gender of respondent (1= male, 0 =female).
Hhn11users	Variable: the number of N11 Users in household (1=1, 2=2, 3=3, 4=4, 5=5, 6=6, 7= 7 or more)
N11timenthvar	Dummy variable: respondents travelling northbound at varied times (1=varied, 0=otherwise)

N11timesthvar	Dummy variable: respondents travelling southbound at varied times (1=varied, 0=otherwise)
N11intermedtotal	Dummy variable: respondents making intermediate stops (1=intermed stop, 0=otherwise)
Child14_18	Dummy variable: number of dependents in household aged 14 -18 (1=14-18, 0=otherwise)
Child6_13	Dummy variable for number of dependents in household aged 6 -13 (1=6-13, 0=otherwise)
Childunder5	Dummy variable: number of dependents in household under 5 years (1=under 5, 0=otherwise)
Availcar	Dummy variable: car users and bus users not citing car unavailability (1=car available, 0=otherwise)
Luas	Dummy variable for respondents with origin close to Luas Light Rail Station (1=Important, 0=otherwise)
Dart	Dummy variable for respondents with origin close to DART Heavy Rail Station (1=Important, 0=otherwise)
Extension	Dummy variable for respondents with origin beyond Foxrock Turnoff, on this section of the QBC, bus services are not as frequent (1=Important, 0=otherwise)