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Isles of Scilly Travel Demand Model

Abstract

Submissions for capital funding for transport infrastructure require robust estimates of the benefits that travellers receive from those improvements. This study provides an example of how a travel demand model was used to predict travellers' responses and quantify their benefits from different ferry service options to the Isles of Scilly. This model has been developed using locally collected data, including travellers' observed choices and the choices they say they would make under changed circumstances. The model predicts changes in modal shift and in total travel demand as a result of changes in ferry services. The methodology also provides an enhancement to normal transport appraisal procedures. Firstly, it includes travellers' benefits from improved quality of services and scheduling. Secondly, it uses exact consumer surplus calculations, which allow for variation in travellers' tastes and the possibility of calculating the impact of discontinuation of services.

The Isles of Scilly are located 28 miles off the southwest tip of England. The Isles comprise five inhabited islands, with a combined population of about 2000, and many smaller uninhabited islands and rocky islets. The main industry on the Isles is tourism, which is highly dependent upon the transport links to and from the mainland.

At present there are three commercial services operating between the Isles and the mainland: a sea ferry, a helicopter service and fixed-wing aircraft services. The ferry is now nearing the end of its operational life and will be taken out of service after 2014. In response, Cornwall County Council, on behalf of the Penzance to Isles of Scilly Route Partnership, are preparing a Major Bid Submission to the UK Department for Transport for capital funding support for improved transport links. As part of this bid, a robust cost-benefit analysis (CBA) was required to quantify whether a replacement ferry between the Isles and Penzance is justified.

The aim of the work undertaken specifically in this study was the development of a travel demand model and the quantification of travellers' benefits from different ferry service options, including the option of abandoning the ferry service, to support the CBA.

Data for choice modelling

Both revealed preference (RP), i.e., observed travel choice data, and stated preference (SP), i.e., hypothetical choice data, were collected to develop the transport demand models.

The strength of SP data is in deriving the relative importance of the different aspects of service (price, crossing time, comfort, etc.) in ferry travel demand. However, to derive forecasts and elasticities it is necessary to quantify the absolute scale or sensitivity of mode choice responses and in this respect RP data is essential. Current best practice is to combine RP data with SP data, where relevant, and this methodology was used in the present study. In a joint analysis, the main information concerning the relative importance of price and service comes from the SP data, while information concerning the overall likelihood that a traveller will choose a particular mode is derived from the RP data. Joint analysis exploits the specific strengths of the two data types.

A programme of SP and RP surveys was therefore undertaken during the summer operating season in 2005. The surveys were conducted with both non-resident visitors and residents of the Isles.

The design of the SP survey

Respondents participated in three experiments in the stated preference survey:

- a **within-mode** experiment in which respondents are asked to choose between two hypothetical ferry alternatives for travel;
- a **between-mode** experiment in which hypothetical ferry, airplane and helicopter alternatives are compared;

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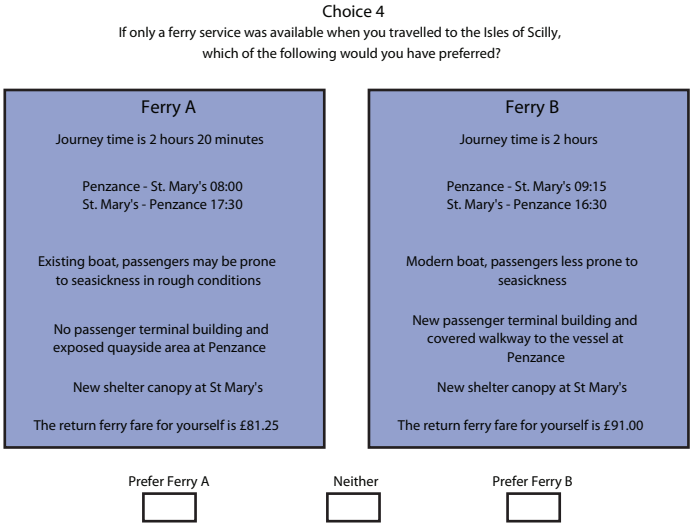
- a **between-mode** experiment in which hypothetical airplane and helicopter services only are available (no ferry is available).

The choice cards for each experiment were specifically generated for each respondent so that the experiments were realistic for respondents. This was particularly important with regard to presentation of fares, which reflected the fare for the group of people who were travelling together to the Isles.

The within-mode experiment was designed to provide valuations for differing ferry attributes, e.g., ferry journey time, frequency of travel and schedule, quality of boat, harbour-side characteristics and price.



The between-mode choices presented hypothetical options for each of the three modes of travel to the Isles. Access information for each of the alternatives was provided by the respondent (and was not varied in the experiment). In this experiment respondents always had the option of saying that they would not make the journey. In the last between-mode experiment, no ferry services were available to respondents.

At the completion of the stated preference choice exercise, questions were asked about the respondent's current journey frequency to and from the Isles. These questions were followed by stated intention questions asking how the respondent's frequency of travel would vary under certain scenarios, specifically with an improved ferry service and with no ferry service. This information was used to calibrate the trip frequency models.

Data collection

Before the data collection commenced, sample size targets were set to ensure that traveller responses could be quantified for three travelling segments to and from the Isles: (i) day-trip visitors, (ii) staying visitors and (iii) Island residents, business travellers and those visiting friends and relatives.

Over 1800 face-to-face RP surveys were carried out with non-resident travellers to the Isles of Scilly, across the day-trip and staying segments. As part of the RP survey, respondents were asked whether they were willing to participate in a subsequent (telephone) SP survey and over 400 SP surveys were conducted with the non-resident travellers to the Islands. Residents were posted RP surveys and over 250 RP surveys were returned, reflecting a response rate of nearly 30%. Of those who responded to the RP surveys, about 60 went on to participate in a detailed SP survey.

The structure of the model

Because of the importance of ferry for travel to the Isles, it was necessary that the travel demand model reflect both changes in modal shift and changes in total travel demand as a result of changes in ferry service level. Disaggregate discrete choice models were developed to reflect mode choice and travel frequency changes for each travel segment.

The mode choice model results

The RP and SP data were used jointly to estimate mode choice models (for methodological details, see Bradley and Daly, 1991). The resulting model coefficients were highly significant for all segments. The best models, from a behavioural perspective, were those which incorporated (household) income-specific cost sensitivity, resulting in income-specific values of time for access time (for the visitor models only) and ferry time. The model for day-trip visitors also incorporated separate values of time for business travellers. Separate business values of time could not be identified in the other segments. The resulting values of time are presented below.

Ferry values of time (£/hour, 2005 prices)

	Day-trip visitors	Staying visitors	Residents & others
Business ferry time	£24.07	(not estimated separately)	(not estimated separately)
Personal ferry time:			
Household income < £60k per year	£11.82	£5.01	£9.85
Household income > £60k+ per year	£16.09	£22.22	£12.60
Unknown/not stated income	£14.71	£13.31	£11.41

For non-business travel, the values of ferry time have been well estimated and are reasonable and we have therefore recommended that they be incorporated in the appraisal procedure without adjustment. As noted above, it was only possible to estimate travel time valuations for business travel in the day-trip visitor segment; therefore for appraisal we have recommended that adjustments be made so that WebTAG[1] values of time are for used for business travel.

The resulting valuations for the quality improvements, both for the new ferry and for the harbour improvements at Penzance and St. Mary's, also appear to be reasonable. The following table compares the average willingness-to-pay to save ferry travel time to the average valuations for the quality improvements investigated in the study, namely the introduction of the new ferry and for harbour improvements (both at Penzance and at St. Mary's together).

[1] WebTAG is the UK Department for Transport's website for guidance on the conduct of transport studies, including advice on the modelling and appraisal appropriate for transport schemes.

Willingness-to-pay for ferry time savings and quality improvements (2005 prices, per one-way trip)

	Day-trip visitors	Staying visitors	Residents & others
Faster ferry (30 minutes saving)	£7	£5	£5
New ferry (less prone to seasickness)	£10	£13	£7
Harbour improvements	£6	£5	£10

A secondary estimation procedure was employed to re-estimate appropriate mode-specific constants, using RP information only, as is recommended in the upcoming WebTAG advice on development of demand forecasting models for major public transport schemes (developed for DfT by RAND Europe).

The frequency model results

The frequency models reflect changes in total travel demand as a result of changes in ferry services. For visitors, separate trip frequency models were estimated for day trip and staying travellers. For residents, separate models were estimated for leisure and business travel.

The resulting trip frequency models reproduce the reported changes in trip-making estimated by the survey respondents in the SP survey (labelled as Stated Intentions (SI) data). It is noteworthy, however, that the resulting trip frequency term is not significant (at the 95% confidence level) in any of the models. It is our experience that it is difficult to identify significant relationships between trip frequency and level-of-service changes at a disaggregate level.

Trip frequency model results: predicted and reported increases and decreases in trip-making

	Improved ferry services		No ferry services	
	Model	SI data	Model	SI data
Day-trip visitors	55% ↑		19% ↓	
Staying visitors	25% ↑		9% ↓	
Overall visitors	34% ↑	30% ↑	12% ↓	20% ↓
Residents–personal	29% ↑	20% ↑	13% ↓	30% ↓
Residents–business	16% ↑	15% ↑	8% ↓	20% ↓

As the table shows, both the visitors and the residents tend to predict much higher increases in trip making for the situation with improved ferry services than decreases as a result of the removal of ferry services. It is not clear how reliable these responses are. The model does not reflect this asymmetry, rather it reflects the average response. Additionally, for visitors we see that the day-trip visitors are more sensitive to ferry accessibility changes and for residents we see that personal trips are more sensitive to ferry accessibility changes, both of which we would expect.

Cost-benefit analysis (CBA) requirements

In order to achieve the main objective of the study it was necessary that the model provide the information required for a CBA of the options in full conformance with the principles and practices set out in WebTAG: principally estimates of the traveller benefits and operator revenue.

The proposed changes to the ferry service are expected to alter the demand for the ferry and the competing air and helicopter services. WebTAG guidance suggests the use of the Rule of Half for calculation of traveller benefits in such situations. However, the Rule of Half breaks down if a new mode is introduced or an existing mode is removed from service: the Do-Minimum scenario reflects the latter situation, as the existing ferry is removed from service in 2009 (for freight) and 2014 (for passengers). In this situation an estimate of the consumer surplus requires additional analysis using the travel demand model as an estimate of the demand curve. Specifically, in this study, the consumer surplus for a travelling group is calculated, in utility terms, using the exact integral of the demand function. This is converted into units of money using the model cost coefficients.

The standard components of generalised cost from which user benefits are calculated usually include changes in crossing time and changes in fares (if any). Additionally, for this study the user benefit calculations include a calculation for benefits associated with different timetables and quality benefits, both in terms of the boat and harbour-side improvements. Placing an economic value on these characteristics represents an enhancement to a normal transport appraisal. The enhancement to the benefit calculation obtained by using the exact integral of the demand curve also allows account to be taken of the unmeasured heterogeneity of preference for different modes of travel.

Forecast results

Future forecasts were produced using a sample enumeration procedure, where the demand model is applied for each travelling group in the (weighted) RP survey sample. This procedure allows representation of the socio-economic variation in the sample, particularly in terms of group size (and characteristics) and household income.

In order to produce future forecasts, for each forecast year, the user specifies the ferry service characteristics, e.g., type of ferry, ferry journey time, ferry timetable, harbour-side quality and fares, and fare adjustments factors for the helicopter and airplane, if relevant. Other model inputs include information on ferry capacity, forecast changes in values of time, discount rates, etc.

The travel demand model then predicts for each observed travel group the probability of choosing a specific mode of travel, given the characteristics of the ferry and other modes. Adjustments to the total number of trips for any year are also calculated, depending on the overall travel accessibility. In certain forecasting scenarios the demand for ferry travel predicted by the models may exceed the ferry capacity. In these cases the demand forecasts are adjusted by introducing a 'shadow price' for ferry that reduces overall demand to the exact capacity of the boat.

Tests have been conducted to examine the resulting ferry fare elasticities obtained from the model. These are presented on the following page.

Ferry fare elasticities by travel segment

Segment	Elasticity
Day trip	-0.7
Day trip (for VFR purpose)	-1.1
Day trip (for business purpose)	-0.8
Long-stay trip	-2.0
Long-stay trip (for VFR purpose)	-1.9
Long-stay trip (for business purpose)	-2.2
Residents (for leisure purpose)	-2.0
Residents (for business purpose)	-2.0
Total	-1.3

It is difficult to compare these elasticities with those reported in other studies, since none of these other studies is directly comparable with the Isles of Scilly situation. Perhaps the most comparable are ferry passenger elasticities provided by the Scottish Office Industry Department study on fare price elasticities, which ranged from –0.8 to –1.5 for specific Scottish ferry routes. Certainly the elasticity figures found from this study are consistent with the SOID figures, with higher elasticities for those segments, i.e., staying visitors and residents, who may consider a wider range of travel alternatives to the Isles.[2] The figures are also consistent with unpublished findings from other RAND Europe studies.

The model has since been used to quantify the specific traveller benefits for a number of different ferry service options by the Penzance to Isles of Scilly Route Partnership.

[2] SOID. (1992) *Fare Price Elasticities on the Caledonia MacBrayne Ferry Network*, Scottish Office Industry Department Research Paper.

Further reading

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