EXPERIENCE WITH USING THE BLAISE SYSTEM FOR CONJOINT MEASUREMENT OF TRAVEL BEHAVIOUR

John Polak
Transport Studies Unit
University of Oxford

Kay Axhausen
Centre for Transport Studies
Imperial College

Jeffrey Oldham
Department of Computer Science
Stanford University

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1 INTRODUCTION

During the past decade the development of sophisticated CAPI interviewing software has had major impacts on the conduct of data collection in a number areas of social research (e.g. Baker, 1992; Foxon, 1988; Keller *et al.*, 1990). In the field of Transport Studies where interest focuses on the travel behaviour of individuals and households, the increased availability of CAPI methods of interviewing has coincided with a major growth in the use of conjoint measurement (stated preference) techniques and it has been natural for researchers to explore the scope for combining these two techniques (Ampt *et al.*, 1987; Jones *et al.*, 1989; Jones and Polak, 1992).

The use of computer-based conjoint measurement has advanced rapidly in recent years and is now one of the most active areas of applied transport research, with the results of such work being routinely used by academics, governments and the transport industries in the UK and many other countries. However, the development of complex computer-based conjoint measurement exercises can be far from straightforward and deciding on the most appropriate implementation approach raises many interesting and important questions concerning software design and use.

In this general context, the objective of this paper is to present some reflections the authors' experience in the use of the Blaise system for the conjoint measurement of travel behaviour. We focus in particular on the experience of a study carried out to develop a conjoint measurement procedure to help assess the likely behavioural response of travellers to changes in parking conditions in Birmingham City Centre. We also briefly discuss an ongoing Blaise study into users' attitudes and responses to a new Light Rail system in Sheffield.

The structure of the paper is as follows. In the next section we provide a very brief overview of the use the use of conjoint measurement techniques in transport and discuss the role of CAPI methods in this context. In the third section we outline the background to the Birmingham study and describe the structure of the Blaise program which was developed, pinpointing some of the issues and difficulties which arose during development. The fourth section highlights some specific features of ongoing Sheffield work. The paper concludes with a broader assessment of the future potential of CAPI methods of conjoint measurement.

2 COMPUTER-BASED CONJOINT METHODS IN TRANSPORT

2.1 Conjoint Methods

The term 'conjoint measurement' (CM)[1] is used to refer to a broad class of methods based on the study of individuals' responses in hypothetical contexts consisting of one or more travel alternatives (e.g. alternative modes for the journey to work or alternative service classes for international air travel) which are typically defined in terms of combinations of levels of attributes

[1]Within the transport research community it is in fact more common to refer to approaches based on the study of behaviour in hypothetical contexts as 'stated preference' or 'stated choice' methods. There are in fact a wide range of competing terms (with different shades of meaning) in use in different disciplines; however, in this paper we will use the term 'conjoint measurement' since it is the most widely acknowledged form.

(e.g. fares, travel times etc.). Thus, in principle, CM methods differ fundamentally from more traditional forms of demand analysis based on the observation of actual market outcomes[2].

In a CM exercise respondents are usually required to make some form of evaluation of the alternatives, which typically involves trading-off various attributes against one another (e.g. increases in fare against improvements in journey time). Amongst the types of response that are most commonly sought in CM exercises are: the rating of alternatives on some form of preference scale, the ranking of a set of alternatives in order of preference or a discrete choice from amongst a set of alternatives. From a statistical analysis of such responses it is possible to infer information regarding the respondents' relative valuation of the attributes in the exercise and further, to use this information to make predictions of future behavioural response. As such, CM approaches have found ready application in a wide range of marketing and demand analysis contexts. A good general introduction of CM methods is provided by Louviere (1988) and overviews of relevant work in the field of transport are given by Bates (1988) and Polak and Jones (1993).

The key attraction of CM approaches is that since they involve eliciting responses to hypothetical contexts rather than depending on the recall of actual behaviour, it is possible for the researcher to engineer these contexts so that the data returned are as useful and informative as possible. In particular, CM approaches provide:

- The opportunity to eliminate many of the statistical problems which typically contaminate data from natural markets (e.g. lack of variation in variables and/or multicollinearity). For example, this means that a particular analysis may be able to be carried out with smaller samples and/or greater precision.

- The opportunity to examine the influence of theoretical constructs (such as comfort, image, convenience etc.) for which there may not be directly or easily measurable counterparts in natural markets.

- The opportunity to explore behaviour in response to circumstances that are either currently unobserved or in principle unobservable under prevailing natural market conditions (e.g. likely responses to new services attributes or entirely new modes).

However, it is precisely the hypothetical nature of CM contexts that leads to legitimate concerns over the validity of responses, and which has provided on of the main motivations for the increased use of CAPI methods of administration.

2.2 Role of CAPI Methods in Conjoint Measurement

CM studies have traditionally been carried out using pen-and-paper methods and their complexity has meant that they have been particularly susceptible and affected by to the many limitations of this mode of administration. An important advantage of CAPI methods of CM is that they lead to simplification in the administration of the interview task, not least, through the elimination of

[2]In practice, the distinction between CM and revealed preference data may not quite so clear-cut: revealed preference data frequently consist of a mixture of measured and reported information, each with a distinct pattern of errors and potential biases. Similarly, CM exercises are often designed around an existing pattern of behaviour and so record both kinds of information.

the need for the interviewer to carry a stock of different questionnaire types, show cards and other supporting materials. In addition, a version of the interviewer manual can be loaded into the computer and accessed via a 'help' facility, so that supporting information is available on the spot, if definitional or operational problems arise during the interview. Benefits also arise in relation to the conduct of the interview itself. One key advantage is the standardisation of the interview stimulus; all respondents see the correct information on screen, and there is complete elimination of routing errors and errors in the wording of variable text questions.

However, the key motivation for the development of CAPI methods of CM lies in the capacity of this approach to address the issue of the validity of CM data, by enabling significant enhancement of the realism of the interview context (Bradley, 1988). In particular:

- The travel alternatives presented to respondents can be customised to a very high level, based on reported values, and if appropriate, on the respondents' own perceptions of what type of service changes would be feasible (and hence believable). Full choice set options (e.g. alternative modes available) can also be included in a realistic way.

- A variety of constraints can be incorporated into the exercise (spatial, temporal and inter-personal), and used both to determine the generation of options and to check the feasibility of changes in behaviour proposed by respondents.

- Interviews can be made adaptive, with the experimental design being modified in the course of the interview to home-in on key trade-off points or thresholds. The use of such dynamic experimental designs can ensure internal consistency while at the same time making options as realistic as possible for respondents.

However, this enhanced realism and greater sophistication frequently involves much greater development effort. Hence the selection of an appropriate software platform for the development of such procedures has become an issue of considerable importance.

2.3 Considerations in the Development of Computer-Based Conjoint Methods

There are a number of important software considerations which must be taken into account when contemplating the development of a computer-based CM exercise. These include:

- Ease and cost of development. CAPI methods can in any case tend to be somewhat more expensive to implement than pen-and-paper approaches and this differential can easily widen considerably if the CAPI implementation of CM procedures proves difficult and time consuming or if highly specialised programming skills are required.

- Flexibility of development. The software used for the CAPI development must be capable of implementing the CM procedures. Such procedures typically involve considerable amounts of computation and user/respondent interaction and therefore the development environment should be able to accommodate these requirements.

- Robustness. CAPI software is 'mission-critical'; it is rarely possible to recover from an interview that has been interrupted or aborted to programe failure. It is therefore vital that the software is throughly tested.

Broadly speaking, there are three alternative approaches that can be adopted to the development of computer-based conjoint survey instruments.

(a) Develop the CAPI system using a conventional programming language (e.g., Pascal or C).

(b) Use a specialist 'off-the-shelf' conjoint analysis package.

(c) Use a generic programable CAPI system such as Blaise

The advantage of using a conventional programming language is essentially one of flexibility; it places few if any restrictions on the form of the resulting CAPI instrument and therefore enables the developer to be extremely ambitious in terms of the complexity and context of the CM exercise. For example, a recent study has used this approach to develop a CM exercise which was embedded within a computer-based simulation of the operation of an advanced traveller information system to investigate travellers' potential acquisition and use of trip-planning information (Polak and Jones, 1992). However, the disadvantage of this approach is clearly that all basic conjoint mechanisms, as well as all user-interface and file handling must be coded by the developer, making the development effort potentially very time-consuming and expensive.

At the opposite extreme of the development spectrum is the use of package conjoint software. In the field of transport alone there are now at least half a dozen such packages on offer. The use of such packages greatly reduces the burden of the development effort since they include basic routines for conjoint measurement, file handling and interviewer/respondent interaction. Provided the envisaged application fits easily into the standard repertoire offered by these packages then they represent an attractive and cost-effective approach. However, such packages generally have rather limited programmability, and have a clearly defined scope of functionality that cannot be easily extended and so are not well suited to the non-standard or highly innovative applications.

Located somewhere between these two extremes, is the option of using a flexible 'generic' CAPI system such as Blaise as the basic platform for the development of tailor-made CM exercises. In the following sections we briefly outline two examples of this approach.

3 A STUDY OF TRAVEL CHOICE IN BIRMINGHAM

3.1 Context

This use of Blaise arose in the context of a larger study which was concerned with the development and application in Birmingham City Centre of a transport model called CLAMP which allows the analysis of different parking policies for urban centres (Polak and Axhausen, 1989; Polak *et al.*, 1990) .

A key element of CLAMP is a representation of the sensitivity of travellers' choice of parking, mode and travel destination to changes in a range of parking policy variables including parking costs, enforcement effort, parking search times and so on. At the time of the study, little was know about the sensitivity of travellers in the West Midlands to such parking policy measures and so as part of the work associated with the application of the CLAMP model it was decided to undertake a series of survey to calibrate appropriate travel demand for the West Midlands.

3.2 The Survey

The survey consisted of a total of 563 interviews carried out at selected locations in Birmingham City Centre, Sutton Coldfield and Coventry. In these interviews respondents were presented with a number of hypothetical choice situations each based closely around the characteristics of a current 'target' journey to the City Centre. The recruitment of the sample was based on target journeys of three types;

- journeys currently made to the City Centre by car,
- journeys currently made to the City Centre by public transport,
- shopping journeys currently made to other centres that might potentially be switched to the City Centre, if parking conditions were improved.

The overall conjoint exercise consisted of three inter-related exercises dealing with choice of parking type, mode and destination. In each exercise respondents were presented with a number of hypothetical choice sets consisting of alternative travel options defined in terms of a set of attributes. Because of the large number of travel options and attributes involved in the overall decision context, a blocking scheme was used in order to reduce the number of simultaneously varying attributes in each experiment and ensure that respondents were not required to answer an unreasonable number of questions,. As a result, each respondent took part in only two of the three possible conjoint exercises (See Figure 1).

It was decided to carry out the survey separately for work- and shopping travellers, as the behavioural framework is substantially different for these two journey types (e.g. arrival time, duration, necessity to carry loads, availability of busses or parking spaces of different type).

The survey program consisted out of the following elements:

- the description of a current relevant journey
- the destination choice conjoint experiment
- the mode choice conjoint experiment
- the parking choice conjoint experiment
- a set of socio-economic questions

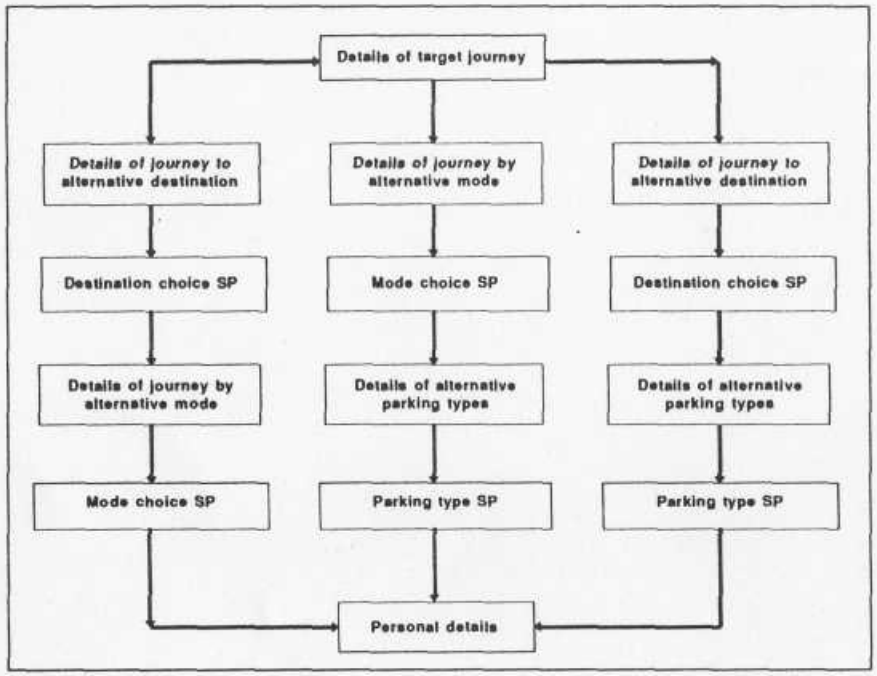
The resulting interviews were still substantial, roughly 20 minutes, but it was felt that the computer-based format and the interest of the respondent in the topic would sustain the attention of the respondent and therefore the quality of the answers.

The experiments were based on fractional factorial experimental designs derived from McLean and Anderson (1984) with a total of 27 or 81 situations, of which each respondent was required to answer a randomly selected set of nine or three situations plus a situation describing the current conditions. In each experiment the current conditions were used to describe the base case of the alternatives.

A feature of the survey was that the values of the attributes used to characterise the travel alternatives were closely based on the characteristics of the identified target journey. Table 1 and Table 2 list as examples the variables used to describe the parking alternatives and the rules,

which were used to adapt the base values according to the experimental design. Comparable sets of variables and rules were defined for the other two experiments.

FIGURE 1 Global Structure of the Interviews



3.3 Implementation with Blaise

The computer-based survey implementing this design was developed using Blaise v.1 and Turbo Pascal v4. The interview was divided into blocks matching the five main elements of the interview. The total amount of BLAISE code runs to about 2000 lines including comments.

The main problems encountered in the process were:

- It was impossible to compile all blocks of the interview as one program due to code segment size limitations of the Turbo Pascal compiler used. It was therefore necessary to generate three different versions of the interview matching the three main routes through the interview.

TABLE 1 Attributes used in the Parking Choice Experiment

Attribute	Description
ACCESS TIME	Access time to the City Centre by car.
SEARCH TIME	Time taken to find a parking space following arrival in the City Centre.
EGRESS TIME	Time spent walking to final destination from car park or public transport stop.
PARKING COST	Money cost for parking in the City Centre.
CHANCE OF A FINE	The number of occasions out of ten on which the respondent expected to be caught performing an illegal parking act.

TABLE 2 Rules used to Set Levels of the Attributes in the Parking Choice Experiment

Attribute	Number of Levels and Values	
ACCESS TIME	3 levels:	-20%, unchanged, +20%

SEARCH TIME	3 levels:	IF Search = 0 THEN
		0, 3min, 6min
		ELSE
		-50%, unchanged, +50%

EGRESS TIME	3 levels:	IF Search = 0 THEN
		0, 3min, 6min
		ELSE
		-50%, unchanged, +50%

PARKING COST	3 levels:	IF Fee = 0 THEN
		0, +20p/hour, +40p/hour
		ELSE
		-50%, unchanged, +50%

CHANCE OF FINE	3 levels:	-50%, unchanged, +50%

FIGURE 2 Example of a Standard Question Screen

```
What was your main mode of travel to Birmingham City Centre?
                ----

1. By car as driver
2. By motorcycle/moped
3. By plane
4. By bus
5. By coach
6. By train
7. By taxi
8. By bicycle
9. By foot

Mode
```

FIGURE 3 Example of a Parking Choice Comparison

```
Which type of parking would you choose?

                 Access     Search     Egress     Parking
                 time       time       time       Fee
-----------------------------------------------------------

Free on-street   18 min     9 min      8 min      Free

Metered          20 min     3 min      5 min      250 p

Illegal          25 min     2 min      2 min      £15 fine
                                                  1 in 10
                                                  times

(enter code)
1: Free on-street          3: Illegal
2: Metered

PressCR
Choice
```


- The generation of the layout of the conjoint option screens (See Figure 3) had to be implemented by hand due to the absence of any screen drawing and positioning tools. The bulk of the Blaise code was concerned with this problem.

- There was no control over the speed with which the screens were generated. It was felt that pauses or blank screens of a specified duration would have been useful during the conjoint experiments. A blank screen associated to a dummy question had to be used instead.

- The need to use dummy questions to generate introductory, help or good-bye screens.

- It was impossible to read the full 81 situation experimental design into Blaise using the external file feature. It was therefore necessary to divide the design into three equal parts in advance.

In spite of these difficulties the overall experience with Blaise in Birmingham application was very encouraging. Although the development effort was substantial (around 2 person-weeks) we are confident that this was significantly less than would have been entailed in developing a CAPI instrument of similar complexity and robustness using a conventional programming language.

4 ATTITUDES AND RESPONSES TO A NEW LIGHT RAIL IN SHEFFIELD

4.1 Context

Blaise is currently being used to develop a conjoint measurement survey which will investigate the preferences and responses of potential users of the Sheffield Supertram system. The Sheffield Supertram is one of a new generation of urban light rail systems which are be introduced in the UK and the first lines are expected to come into operation early in 1994.

4.2 The Surveys

A sample of several hundred potential Supertram users will be interviewed in November and December 1993 and again one year later, to form a short panel. The interviews will consist of a series of conjoint exercises which will explore potential users' sensitivity to various attributes of the proposed Supertram service and their likely use to hypothetical Supertram services, considered as an alternative to existing modes of travel. In order to enhance the realism of the stated preference exercises, the interviews will be based closely on the characteristics of existing journeys. Data from the surveys will be used to develop a variety of econometric models of travellers' behaviour and in particular to explore the forecasting performance and temporal stability models developed with conjoint data.

4.3 Some Issues of Implementation within Blaise

The work in Sheffield has been able to benefit from a number of enhanced features of later versions of Blaise. In particular, we have made extensive use of the support provided for user-defined questions and functions in v.5/2.5 to explore alternative approaches to the implementation of conjoint measurement routines. Although this work is still in progress and consequently final design decisions have not yet been made, a number of interesting issues have nevertheless arisen.

The main issues have been:

- Should Blaise or Pascal be responsible for displaying a conjoint task? The advantage of using Pascal is that we have access to a full range of screen control and drawing capabilities, obviating the tedious coding of display screen that was necessary in the Birmingham survey. However, the disadvantage of this approach is that there is scope of interference and confusion between Pascal and Blaise screen handling (e.g. Blaise always display its default screen before invoking a user-defined question, which can cause particular problems when paging backwards through a questionnaire).

- Should Blaise or Pascal be responsible for control of flow between conjoint tasks? Whilst Blaise's **if-then-else** construct is sufficiently powerful for most routing requirements, the lack, for example, of array variables means that handling complex multi-dimensional iterative tasks is laborious. However, to enable Pascal to exercise control of flow, information must be preserved in Pascal variables from one procedure invocation to the next.

These issues are discussed in more detail in Oldham (1993).

5 CONCLUSIONS

In this paper we have briefly considered some of the main issues surrounding the use of the Blaise system for implementing conjoint measurement procedures. It is already the case that Blaise offers one of the most attractive environments for the development of such procedures, and it is our hope that the forthcoming announcement of Blaise v3 will further enhance the systems capabilities in this respect.

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