



27th Australasian Transport Research Forum, Adelaide, 29 September – 1 October 2004

Paper title: **Traveller Information Services: features demanded vs features supplied**

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Abstract (200 words):

Most Australian states have a publicly funded traveller information service in operation. These services are primarily real-time or regularly updated traffic or public transport network information. They clearly provide some benefits to the travelling public, but there has been limited reported analysis of user opinions of the services and even less reported analysis of user preferences for the type of information provided prior to service set up. Traveller information services are an ITS application which can provide significant benefits to the travelling public. When applied at a suitable scale, they also offer an opportunity to reduce negative environmental impacts of transport, such as greenhouse gas emissions. To have these systems gain acceptance and be in use at a scale that will produce environmental benefits, demand-side analysis of user requirements is needed. Better understanding of end user needs has the potential to remove barriers to use and lead to improved outcomes for policy development and investment in traveller information services. This paper describes the application of a computer-based stated choice survey tool to create a structure and set of tools for describing the responsiveness of travellers to a traveller information service. The first results of a pilot survey using this tool are presented to demonstrate the ease of obtaining appropriate traveller preference information and its value in design or redesign of traveller information systems.

Introduction

Intelligent Transport Systems (ITS) now encompass a broad range of products, from smart cards for public transport to active incident detection at road intersections. A common characteristic of these diverse applications is their potential to address a range of persistent and traditional transportation problems. Appropriate applications at a suitable scale have a real potential to reduce the impacts of growing motor vehicle traffic in a variety of ways. These range from reducing congestion, to making both motorised and non-motorised travel safer, to encouraging mode shift to public transport. Many of these outcomes offer an opportunity to reduce greenhouse gas (GHG) emissions in the short to medium term from the current and future fleets of motorised vehicles prior to a cumulative fleet changeover to low or zero emission vehicles. Early reduction of GHG is important since its effect on world climate is cumulative.

However, widespread adoption of ITS technologies is needed if the greenhouse mitigation potential of ITS is to be realised. This is challenging in a market characterised by such great diversity (Smith et al., 2003). There are a wide range of products at various stages of development with a corresponding variety of developers. End users lie on a spectrum from the highly technical developer-user to the low-knowledge traveller. Thus, it is not surprising that recent European research (Weber and van Zuylen, 2000), corroborated by Australian industry experience, suggests that barriers to transport innovation are market and institutional, rather than technological. Better understanding of end user needs and perceptions has the potential to remove such barriers and lead to improved outcomes from ITS research, investment and policy.

As ITS markets evolve, the stakes in making public policy and investment decisions increase (Batt and Katz, 1997). Thus, there is a need to understand consumer behaviour, not only for market success, but also for the creation of equitable public policy (Batt and Katz, 1997). While private sector investment decisions may take into account market-based or user surveys, few government investment decisions incorporate user preferences in their decision making toolbox.

To date, the design of ITS products for the market has been predominantly supply-side driven. The model we propose recognises that a closer link between user responses and ITS research development and design, can lead to more efficient and better accepted systems. Traveller information services provide a good example of how these techniques can assist both the public and private sectors in developing ITS products to both maximise returns on investment and to maximise benefits of policy decisions.

This paper demonstrates the application of stated choice techniques to create a structure and set of tools for describing the responsiveness of travellers to a traveller information service. Using choice-based conjoint analysis, the tool closely replicates the trade-offs and decision processes used by consumers in using such a product. Sample results obtained while demonstrating the tool are presented. The sample results show the relative ease of obtaining appropriate traveller preference information via the computer based survey tool and its value in design or redesign of ITS products including traveller information services. In this paper, we show how marketing science offers tools that are able to match ITS attributes to consumer preferences better. This is seen as an essential stage—that is currently missing—to secure ITS market penetration and hence achieve community gains.

Traveller Information Services

Traveller information services include real-time navigation in vehicles and traffic information, pre-trip and on-trip public transport information and pedestrian maps. State transport agencies are investing heavily in technology to monitor road and traffic conditions and to communicate this information to the public. The majority of states across Australia have a publicly funded traveller information service in operation. A number of motoring associations also provide traveller information services. Virtually every radio station has traffic reports, television stations show coverage of road congestion, most state and territory transport agencies have a website showing the status of traffic and most have a telephone number that provides some level of traveller information. In fact, across Australia, there are currently some 30 numbers providing traveller information to varying degrees. These services are primarily real-time or regularly updated traffic or public transport network information.

However, there has been limited reported analysis of user opinions of the services and even less reported analysis of user preferences for the type of information provided prior to service set up. Many of the mechanisms for delivering information to drivers are expensive, have long lead times, or require complex partnerships. Given the expectations of drivers for good information and the possibility of costly mistakes and redundant services, it is critical that mechanisms be carefully chosen and implemented. This is where stated preference or stated choice survey techniques can be used to assist in making investment and policy decisions.

Traveller information services can provide significant benefits to the travelling public in time saved, avoided congestion, reduced stress and the avoidance of unsafe conditions. At a large enough scale, these benefits also offer an opportunity to reduce negative environmental impacts of transport, such as air pollutant and greenhouse gas emissions, in the short to medium term. In a recent study (Smith et al., 2003), it was found that real-time traffic information provided on just main radial and orbital routes might reduce overall CO₂ emissions from freight and passenger traffic in the greater Sydney area by 2.6%. More widespread application might be expected to produce further savings.

The application selected for our demonstration tool is based on the USA “511” service. 511 is a national 3-digit phone-in number for traveller information (Johnson et al., 2001). In Australia, the federal government’s *Auslink* document (DOTARS, 2004) commits to the establishment of a National Traveller Information Number (NTIN), in conjunction with state and territory governments and *ITS Australia*. Initial trials of an NTIN are beginning and it is intended to expand the service. A better understanding of the service features is likely to encourage service use and would therefore be helpful. Thus the NTIN is a topical ITS application with a number of stakeholders from service suppliers, information providers, road and public transport authorities, plus, of course, the community as users of the service. Our demonstration design to market tool considers a hypothetical NTIN service, “123GO”.

Survey and analysis methodology

Stated preference and choice based survey techniques have been used in the field of transport research for more than 20 years (Hensher and Louviere, 1982; Louviere et al. 2000), predominantly in travel demand estimation. These methods offer a formal structure and set of tools for describing the responsiveness of market participants for particular hypothetical products (goods and/or services) that are not yet available in the marketplace. Using stated

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preference techniques – traditional conjoint or discrete choice modelling - respondents express their preferences for various products or services. In conjoint (“consider jointly”) analysis respondents are asked to rate or rank a set of total product descriptions. The value placed on individual product features (price, speed etc.) are then decomposed from the survey results. In stated choice, respondents make a number of decisions—that is, they are asked to choose one or none of the products from a set of product alternatives.

Both techniques provides quantitative answers to questions such as the following:

- What customer values or utilities are attached to different product features? For example, given that an in-vehicle console provides the driver with real-time information, how important are GPS navigation features?
- How do different customers value product attributes? For example, a commuter might not require GPS navigation while a plumber who has to travel to unfamiliar suburban streets would find it useful.

via part-worths (conjoint) or utility functions and probabilities of choice (discrete choice modelling).

Conjoint analysis and discrete choice

Conjoint and discrete choice models closely replicate the trade-offs and decision processes used by consumers in purchasing products like ITS. They mirror the fact that when consumers make purchases, they simultaneously weigh up choices such as service features and price. They thus provide useful tools for understanding and anticipating behaviour.

Conjoint analysis can model consumer priorities for a wide range of ITS features and price sensitivities, allows benefits-based market segmentation, can provide demand and revenue forecasts, can also forecast the usage growth and correctly predict optimum pricing levels (Batt and Katz, 1997).

Conjoint analysis assumes Lancasterian consumer theory, where consumers view economic goods as bundles of features, and suggests that preferences for economic goods can be decomposed into separable preferences for their constituent attributes or benefits (Louviere, 1994). That is, the utility or value of a product, to a particular person may be expressed by the sum of the utility of individual features. It is assumed that consumers prefer products which offer them the best total utility and that their preferences are based on their personal characteristics and tastes. Thus if the preferences of a sample of consumers for hypothetical products are collected, the weights different types of people place on product design features may be estimated, usually from ranking or rating evaluations. These in turn can be used to estimate the probability of purchase/use of any particular design by individuals and groups. The traditional conjoint has the benefit of individual analysis, but the prediction of market share is done by summing results across people using a share simulator. There are also problems with the interaction effects (which in most conjoint analysis studies are ignored because of the high number of profiles to be evaluated), non-linearity of levels of the attributes and the translation of low ranking/rating into non-purchase. Many of these limitations have been overcome by discrete choice modelling.

Interest in use of discrete choice as applied to choice-based conjoint has grown considerably over the past decades for good reasons (Louviere et al., 2000): people *make choices* when purchasing products and services, features can be unique to one alternative, different types of decision structures can be explicitly tested, and choices are modelled directly without the ad-hoc rules required in the traditional conjoint. However, in practical applications, the choice

data is usually not enough to estimate the models at the individual level, but aggregated to segment or to the entire population of the sample. The individual behaviour can be accounted for by including the individual characteristics in the model.

In the design of our survey tool, we used discrete choice techniques to establish quantitative guidelines to identify:

- the need or market penetration of the service (i.e. would the service actually be used);
- how users want to access the information and the relative importance individuals attach to attributes;
- price sensitivity (which could also be used to determine possible revenue streams).

Experimental design

Two experimental designs are necessary for discrete choice: one to generate profiles and another to place the profiles into balanced choice sets.

We started by selecting the attributes and the levels. Expert knowledge (discussions with IT professionals) and existing literature (Marchau et al., 2002; Johnson et al., 2001) helped us to identify the salient attributes that influence consumers' preference and choice of ITS services. From a managerial perspective, we sought to have actionable levels in attributes in the Australian context. We ended up with 14 levels for the four service attributes considered in "123GO", as shown in Table 1 below. These are: the types of information provided, methods of accessing the information, the frequency with which the information is updated, and price.

The design is unbalanced (one feature has five levels and the other three levels) and some of the levels may have non-linear utility: e.g., one customer may prefer voice recognition to SMS or traffic information to very detailed road and traffic conditions.

Table 1 Features and levels of the Traveller Information Service

| Attributes | Attribute Levels |
|----------------------------------|--|
| Types of information | Roadworks Road and traffic information Tailored road and traffic information |
| Methods of accessing information | Pre-recorded messages Keypad menus Voice recognition Speak to an operator Via SMS |
| Frequency of updates | Twice a day Hourly Continuously |
| Price | \$0.25 - in line with connection fees from most phones \$0.70 - this option is for frequent users \$2.50 - similar price of a Telstra wake-up call |

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As it is impractical as well as unnecessary to present all the possible combinations of the four features in the survey, we used a fractional factorial design, with profiles generated in SPSS – Orthogonal design (27 estimation cards and 6 holdout cards). The full profile of $3 \times 5 \times 3 \times 3 = 135$ cards/stimuli was reduced to a minimum number of stimuli that ensures orthogonality. The fractional design was tested and there were no statistical significant correlations between the main effects and higher order interactions.

The fractional design was then refined, by checking every combination of attributes and replacing the stimuli when a specified pair of attributes should not appear together in one alternative: e.g., information on “road works only” would not need to be updated on a continuous basis or “tailored road and traffic information” is without use if updated only twice a day. Such unlikely combinations have been replaced from the set of possible card combinations and the orthogonality tested again.

Subsequently, the stimuli were duplicated in a second bin and pairs of stimuli were randomly selected. Two conditions were, however, considered: 1) Pairs of cards were prohibited if they did not differ in at least two attributes or features 2) The set of pairs presented to a particular respondent in the survey should contain 12 different stimuli (six pairs of stimuli) in the survey. In Figure 1, we present the steps followed for the experimental design.

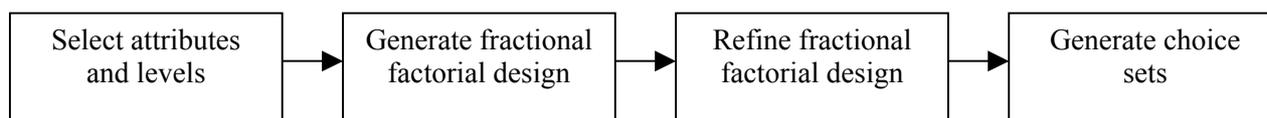


Figure 1 Sequence of operations in experimental design

Conducting the Survey Electronically

A computer-based survey was designed for this study.

The advantage in using this medium - a program instead of other traditional paper based methods - is in conceptualisation, as rich media may be used in place of text descriptions that may be less engaging. In our survey tool, we use recorded voice messages and pictures to illustrate the services provided. It was particularly important, in this pilot of a telephone based service, to check respondents ability to both recall voice information, and associate the information and means of delivery with pictograms used in the survey.

The tool is also efficient in terms of data entry, as responses are directly collected in electronic format for analysis and there is very low response time. We are however aware of the serious disadvantage of sample bias, as only persons having access to personal computers and the Internet may be considered, and this aspect has to be considered when results are to be interpreted and used.

Our survey tool is designed in Microsoft Visual Basic. An interviewer sits with the respondent, who clicks through the program, and in the process, learns about the features of a traveller information service. Then, the program presents respondents with a series of choices from which the respondent must pick one, or none, of two traveller information packages presented to them. ‘Screen shots’ from the demonstration tool describing the features of the service are shown in Figures 2 and 3.

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Types of Information



Roadworks

This feature provides information about delays, road closures and details due ONLY to roadworks, on-road events and traffic incidents. To hear an example of this feature, click on the icon.



Road and Traffic

This feature provides traffic information in a "drive-time" style format similar to that you would hear on the radio. To hear an example of this feature, click on the icon.



Tailored Road and Traffic Info

This feature provides both traffic and roadwork information tailored specifically to the roads you usually travel. To use this service, you would need to pre-register as a user and specify the areas or routes you need information for. For example if you regularly travelled between your home and the city or between the airport and the city, you would need to register these specified routes. To hear an example of this feature, click on the icon.

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Figure 2 Types of information

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How you can receive the information

| | |
|--|---|
|  <p>Pre-recorded Messages</p> | <p>This option is pre-recorded information. Information for road conditions, traffic information and incident information across the whole road network is provided in a continuous stream. There is no opportunity to jump forward through the information. To hear an example of this feature, click on the icon.</p> |
|  <p>Keypad Menu</p> | <p>This option is pre-recorded information. It allows you to select a menu option from the keypad for the type of information you require and for the area you are interested in. To hear an example of this feature, click on the icon.</p> |
|  <p>Voice Recognition</p> | <p>This option is pre-recorded information. It allows you to ask for the type of information you want and the location you require via a voice recognition system rather than select a menu option from a keypad. To hear an example of this feature, click on the icon.</p> |
|  <p>Speak to Operator</p> | <p>This option allows you to speak with an operator for the information you require. Note however, if the system only provides roadworks information, the operator will NOT be able to provide information about traffic delays as well. To hear an example of this feature, click on the icon.</p> |
|  <p>SMS</p> | <p>This option requires a mobile phone. You send a text message with the information and the location you are interested in and the information is sent to your mobile phone in response. To see an example of this feature, click on the icon.</p> |

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Figure 3 Methods of accessing the traveller information

The survey also includes a series of questions related to respondents work and non-work trip-making behaviour, socio-demographics information, and questions related to the use of mobile phones. These latter questions were to gauge extent the respondents use of new telecommunications technology including SMS.

A pilot survey was carried out in Brisbane, Perth, Sydney and Melbourne, in order to improve and validate the definitive survey instrument. As a result, we changed the wording for some questions where the language was considered ambiguous (Tourangeau et al., 2000). The pilot was also used to check the stimuli (orthogonality) and their comparisons and also highlighted the benefit of “warm-up” choice sets to ensure that the respondents understand tasks (Carson et al., 1994).

As stated above, when the survey commences, the respondent is presented with two “cards”/stimuli illustrating two traveller information packages (see Figure 4). The respondent is asked to evaluate these stimuli in terms of their desirability. They may choose to use either System A or System B, or neither of these. Each respondent is given six of these choice sets to consider. Respondents are assumed to opt for the alternative or ‘package’ which maximises their utility. While this number of comparisons is relatively low in terms of marketing research, where respondents typically evaluate between 16-32 sets, it is consistent with transport research practice where choice sets are typically less than nine (Hensher et al., 2001). Although we might have increased the number of choice sets in the pilot interviews we conducted, respondents commented favourably on the length of the choice survey, with some respondents complaining that the socio-demographic questions were too numerous. The respondent manifestations of burden or boredom also prevented us from using repeated stimuli in the interviews.

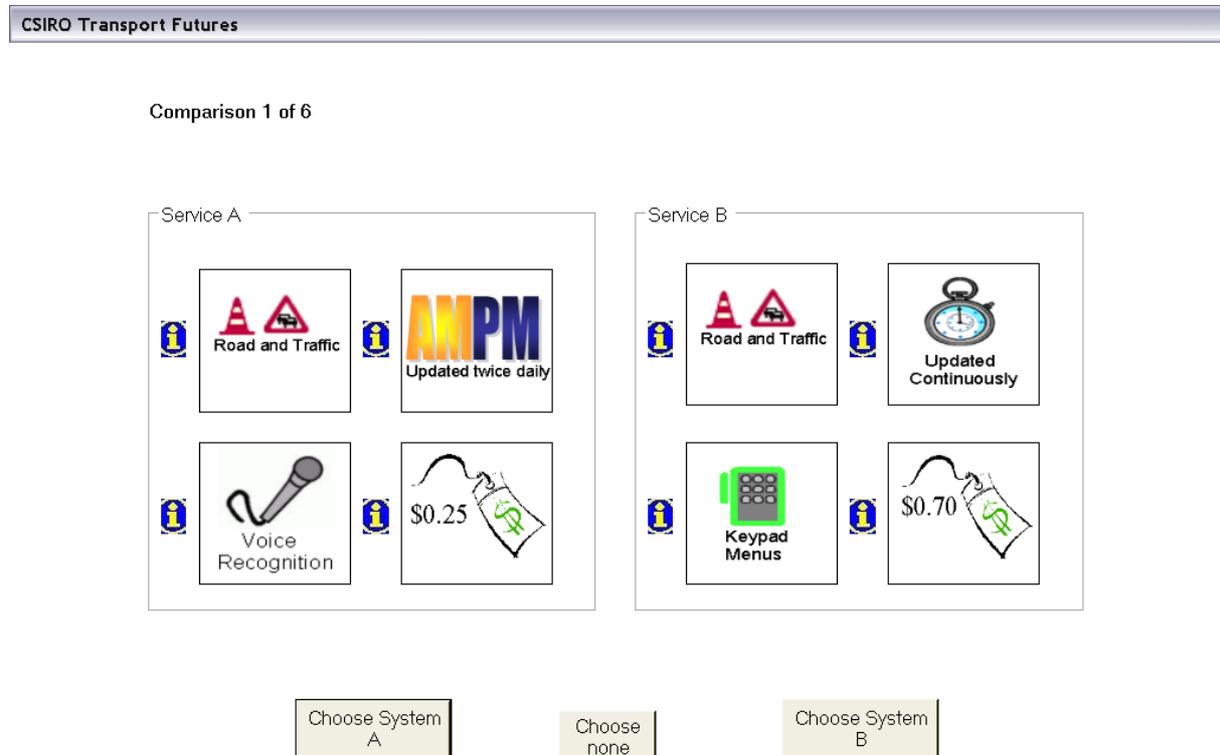


Figure 4 An example of a pair-wise comparison presented to the respondent

Demonstration Results

The results of the pilot interviews follow. As this was a demonstration project, we used a convenience sample, with about half of the respondent set consisting of researchers at CSIRO sites. A total of 54 respondents were interviewed resulting in 380 records for the choice model. In the survey we collected information on respondents trip making behaviour and mobile phone use together with information about their gender, age, occupation, and their home location.

Characteristics of the Pilot Respondents

The sample was balanced in terms of gender: 28 women and 26 men, and even in the broad age group categories recorded.

Trip-making behaviour: 34 of the 54 respondents commuted to work by car five times a week, 2 even on weekends, and the rest less frequently. Half the sample said their work start and finish times were flexible. Only 11 of the respondents use cars for work-related trips (excluding commuting), but more than half made at least two non-work trips by car in a typical weekday. Half of the respondents travel within the state or interstate by car more than 4 times a year.

Use of mobile phones: 29 of the 54 of respondents use mobile phones more than once a day for phone calls and 22, predominantly younger respondents, use SMS.

Demonstration results of traveller information service attributes

In terms of lexicographic behaviour, we found only four persons who always picked up the option which was best in terms of a particular attribute (Saelensminde, 2001). Two persons selected frequency of update, while the other two picked price, or methods of accessing information respectively.

The “taste weights” or importance of individual features of the product to individuals were estimated by analysis of their choices in the multinomial logit estimation facility included within the BIOGEME package (Bierlaire et al., 2003). Multinomial logit models link the “utility”, or desirability, of a choice to the features of the chosen product and the characteristics of the person making the choice. The model considers a linear utility function with all four attributes as generic, that is as applying to all alternatives.

Analysis assumes that the respondents base their choices on an evaluation of the product attributes, the utility of which consists of a structural part, V , constant over time and common to all respondents, and a stochastic part, ϵ that captures variations between different individuals and measurement errors. The multinomial logit (MNL) model applied assumes that the value of V is identical for all consumer choices, and that the stochastic component of all choices (including choosing none of the services) follows the identically and independently distributed Gumbel distribution. Some very early results from the MNL modelling are presented in Table 2 as examples only.

Table 2 Results from multinomial logit model in BIOGEME

| Utility parameters | | | |
|--------------------|---------|-----------|--------|
| Name | Value | Std error | t-test |
| ASC1 | 0.0101 | +1.43e+07 | 0.001 |
| ASC2 | -0.0101 | +1.43e+07 | 0.001 |
| Delivery mode | -0.0015 | +0.072 | -0.021 |
| <i>Information</i> | 0.6412 | +0.180 | 3.557 |
| Frequency update | 0.179 | +0.139 | 1.289 |
| <i>Price</i> | -0.698 | +0.158 | -4.426 |

We expected the sign of coefficient for price to be negative since the increase in price would diminish the utility. This was confirmed in this very small sample, as well as the signs carried by information and frequency. The results show that more information and current information are more valued by respondents and provide higher utility. We also expected to see a positive sign for the mode of accessing the information. Although attempts of ordering the levels of the attribute according to the degree of interaction with the system have been made – “pre-recorded messages” have the lowest level and “speak to human operator” the highest - the results are very inconclusive. The insignificant coefficient (with a negative sign for this example) may be the result of the sample bias.

The results show that for our respondents, the most important attributes are price and information, followed by frequency of update. These results are only indicative of the possible ways to further investigate the demanded features for TIS services. Using discrete choice, we would be able to evaluate the importance individuals allocate to various TIS service attributes and the market penetration of the service.

More detailed analysis is proceeding, to investigate interactions of choices with respondent characteristics and also more complex utility functions. The additivity of the main effects model is appealing for simplicity reasons, but significant interactions may be expected, especially between mode of delivery and type of information. There are also issues with testing the Independence of Irrelevant Alternatives (IIA) property. When competing alternatives are similar (e.g., voice recognition and menu press buttons), this is not viable. Nesting strategies or more complex specifications of the systematic utility component may be used on a much larger sample to overcome some of the limitations of MNL.

A properly constituted sample, rather than the current convenience sample of colleagues, friends and relatives, will be needed to provide results for other than demonstration purposes. The research team are about to apply the tool to a real, rather than hypothetical travel information service, using a representative survey sample. One early finding we are anxious to test is a significant difference in preferences between our colleagues in information technology related jobs and friends or relatives in other occupations.

Conclusion

This paper has shown how choice based survey techniques can identify desirable features for some Intelligent Transport Systems products. The techniques might be used to improve product uptake for new and existing products. “Design to market” can identify optimal packages of product features to include in new products. “Present to market” can identify the

features of existing products most attractive to the market for emphasis in advertising. Traveller information services are just one example of ITS, where marketing research tools, such as conjoint analysis and discrete choice analysis can be used in a practical way to support policy and investment decisions.

Ranking or rating individual product features provide only a rough indication of the relative importance of decision factors. In contrast, when respondents make choices between packages of features in “virtual shopping” experiments, analysis can measure the exact magnitude of their difference in importance, consumer influence and explanatory power (Batt and Katz, 1997). Better understanding of end user needs has the potential to remove barriers to use. This information can then be applied to create a product that will maximise return on investment or maximise the effectiveness of policy decisions or positions. The pilot also showed that such techniques can be applied in testing products where features are experienced rather than seen.

While the demonstration showed the ease of applying both the tool and analysis process, it also, inadvertently, showed a particular value of such tools to ITS developers. If further work confirms our finding of a distinct difference in preference for ITS product features between IT professionals and the general public, it would reinforce the value of gaining market views of potential ITS product features. Just relying on the tastes of ITS designers will be inadvisable if they are likely to have atypical responses to IT technology. Those who are IT professionals, including ITS developers, are asked to “test drive” the tool. Their preferences can then be compared with the survey sample results. The results will give an indication of the potential of such techniques in ITS design.

Acknowledgements

Funding for this research was provided by the new CSIRO Energy Transformed Research Flagship. We are grateful for the helpful comments of the National Traveller Information Number committee members, especially Brent Stafford. The comments of the anonymous referee helped us improve the paper.

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