# THE ROLE OF EMPIRICAL DATA FOR TRANSPORT POLICY ANALYSIS

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*ABSTRACT:*

*Transport policy analysis requires appropriate analytical techniques for the investigation of social, economic and environmental impacts. The use of such techniques requires a balanced approach to the development of transport system models and the collection and analysis of empirical data collection techniques and third generation demand modelling to the assessment of changes occurring as a result of the extension of a tram route in the northern suburbs of Melbourne. The paper will demonstrate how such analysis can be used to develop and assess the potential impact of various policy options using the concepts of situational groups and dimensions.*

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INTRODUCTION

The range and scope of policy analysis in the field of transport has increased significantly in recent years. A concentration on the engineering design of basic roadway facilities has been replaced by an emphasis on the investigation of social, economic and environmental effects of multi-modal transport facilities. This broadening of the scope of investigations has meant that the methods of analysis have needed to be correspondingly broadened. Simple reliance on the extrapolation of usage trends in order to predict future demand has been replaced by the development of methods which increasingly attempt to understand how and why travel is undertaken so that adaptations to changes in the transport system can be better predicted. In particular, there have been improvements in the specification of behavioural models of travel choice, and more recently improvements in the methods used for the collection of empirical data used to describe travel patterns.

"Empirical" is defined in the Collins Dictionary as "relying on experiment and observation rather than theory". Using this definition, it could be argued that empirical observations are somehow in opposition to the use of theoretical models. However, a more realistic assessment is that empirical data and theoretical models can each make a valuable contribution to the analysis of transport policies. The objective of this paper is to demonstrate that empirical observation of travel patterns, and the associated socio-demographic patterns of households involved in that travel, can provide useful information in the formulation and monitoring of transport policies. The paper will refer to a study of mode choice connected with the extension of a tram route in the northern suburbs of Melbourne to illustrate many of the points made in the paper.

THE NATURE OF QUANTITATIVE POLICY ANALYSIS

An essential component of quantitative, as opposed to qualitative, policy analysis is the development of system models. System models have two essential characteristics:

(i) they are simplifications of reality; and

(ii) they are used to predict future conditions in the system.

Given these characteristics it is clear that the nature of models can vary enormously. Although many people instinctively associate modelling with complex computer-based mathematical methods, this is not necessarily correct. Models can vary in complexity from such computer-based methods down to the powers of intuition and experience. A planner's experience is, after all, certainly a simplification of reality and it is used by that planner to make estimates of the likely state of affairs in the system at some future time or after some specific action. In many cases, the judgement of an experienced professional may be the best form of system model. In many other cases, however, such judgement may not be sufficient. Transport systems are, after all, highly complex systems with numerous interactions between system parameters. Attempting to make intuitive judgements of conditions which have not been experienced before is fraught with difficulties. In such cases it may be best to develop a formal model of how the system works, and then use this model to test the effects of various strategies.

Having decided to develop a system model, the question then arises as to how far one should proceed in the development of the model. Is a simple model sufficient to provide answers to the questions which will be asked, or is there a need for a more complex model? In answering this question, one needs to keep in mind some formal concepts of modelling errors, as described by Stopher and Meyburg (1975).

## The Nature of Modelling Errors

There are two basic types of errors which will be encountered in modelling; specification error and measurement error. Specification error arises as a result of basic errors in the formulation of the model. These errors may be due to the fact that the model structure is a simplification of reality and/or the number of explanatory variables included in the model is less than the number of variables actually at work in the situation being modelled. Measurement error arises from the fact that all the variables used in the model have been measured by some form of survey process. This survey process can give use to various forms of error such as sampling error, sampling bias and non-response bias.

The specification error will obviously be a function of the sophistication, or complexity, of the model. As more variables are introduced into the model or as more interactions and relationships are accounted for in more realistic ways, the complexity of the model will increase. Provided that the extra variables are relevant and that the extra relationships are valid, we would expect the specification error (SE) to decrease as the complexity of the model increases, as shown in Figure 1.

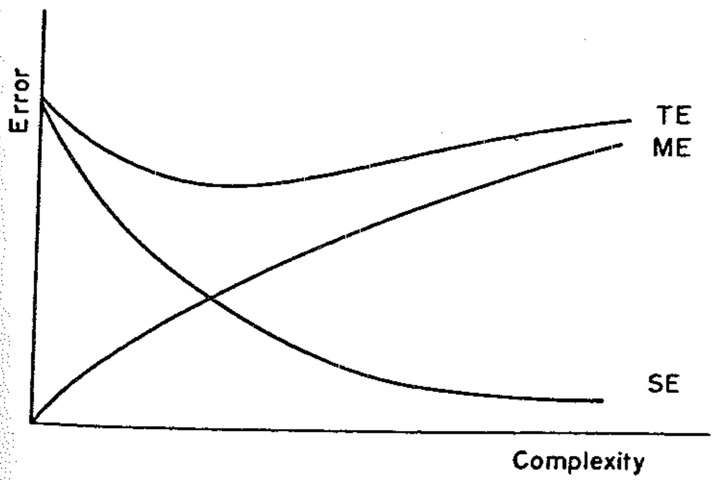


Figure 1. Total Error as a Function of Model Complexity

The measurement error will also be related to the complexity of the model. Since each variable has a certain degree of measurement error associated with it, the inclusion of more variables will increase the total measurement error in the model. As the relationships using these variables become more complex, such as exponential and power functions, then the error in each variable will be compounded. Therefore increasing model complexity will result in an increase in the total measurement error (ME) in the model, as shown in Figure 1.

To obtain the total error (TE) in the model, one must combine the specification error and the measurement error as shown in Figure 1. Having done this, one notices an interesting situation. The minimum total error in the model is associated with an intermediate level of model complexity. Simple models have too much specification error, whilst complex models have too much measurement error, even though the specification error for complex models may be very low. At some intermediate level of complexity lies the model with minimum total error. Trying to identify this level of complexity is, however, quantitatively difficult. All that one can conclude is that very simple and very complex models are both probably equally wrong.

A further lesson can be learnt by considering the situation where the same model specification is used with a different data set, the quality of which is worse than the original data set. The reasons for this deterioration in quality, or increase in measurement error, may be numerous. Perhaps sampling error has increased because of a smaller sample size, or maybe the quality controls on the conduct of interviews or administration of questionnaires was less strict, perhaps non-response was higher, or maybe there was inadequate attention paid to the validation and correction of the data. For whatever reasons, assume that the measurement error is higher at all levels of model complexity as shown by the curve ME2 in Figure 2.

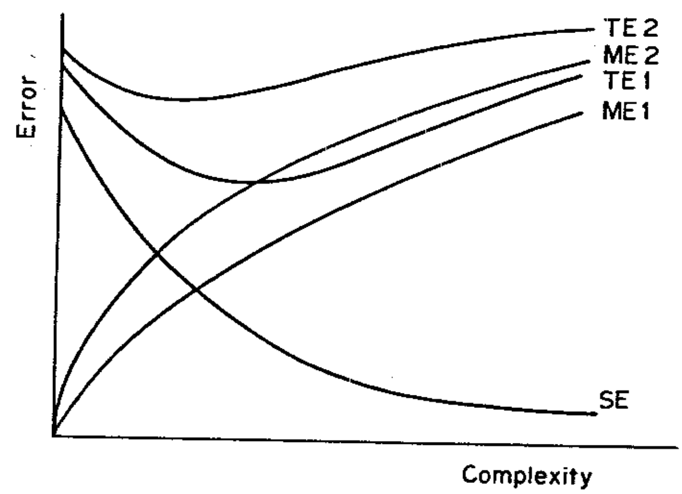


Figure 2. Optimum Complexity as a Function of Measurement Error.

The effect of this increase in measurement error is twofold. Firstly, as expected, the total error is increased for all levels of model complexity. Secondly, the model complexity at which minimum total error now occurs is less than the optimum model complexity encountered with the original data set. That is, when using worse data, one should select a model of reduced complexity in order to minimise total error. This is perhaps counterintuitive to what one might expect; one might reason that in order to compensate for the worse data one should use a better (more complex) model. However, as shown in Figure 2, the lesson is that when one has bad data, one should use as little of it as possible when constructing models.

Another lesson to be learnt from Figure 2 concerns the deployment of resources in the policy analysis area. Given a fixed budget for the conduct of policy analysis, the best use of that budget will result from an even-handed attitude to model development and data collection. The development of complex models is of little use if this leaves little resources available for the collection and maintenance of good quality data. Indeed with poor data available, it would be better to use simpler models than those which have been developed, in order to reduce total modelling error as shown in Figure 2. On the other hand, devotion of most of the resources to data collection will mean that only simple models are available, and these will not take advantage of the high quality data which is available. The best strategy is to have good models and good data, rather than excellent models and poor data or vice versa.

## A Rationale for Eclectic Modelling

As noted above, the only thing one can be sure about in modelling is that the answer will be wrong. This is an inevitable consequence of the fact that models are simplifications of reality, both in terms of theory and measurement capabilities. The skill in modelling is to find analytical techniques which have acceptable correctness for the situation at hand. Note that the previous sentence used the phrase "acceptable techniques" rather than "an acceptable technique". In many cases, it is better to develop several different models of the same situation (with relatively low complexity for each model), rather than devote all the available resources to the development of one complex model. Whilst the complex model may well be better than any of the simple models by themselves, it will rarely be better than the battery of simple models, provided that each of the simple models is developed from significantly different bases.

The use of many simple models in combination is known as eclectic modelling (Armstrong, 1978). It is most useful when there is great uncertainty about the nature of the process being modelled, and when data are not of high quality. The use of eclectic modelling is somewhat analogous to the use of redundant components in many physical systems. For example, rather than develop a better component (at some considerable cost but with a lower probability of failure) one simply uses three cheaper components in parallel. If one of these components fails, then there are still two more to allow the system to function normally. By triplicating each component in this way, the cost of the system is tripled but the reliability of the system may increase more than proportionally, e.g. if each of the components has a 10% failure rate, then the failure rate of the triplicated component system is 0.1% (10% x 10% x 10%). The same applies to systems modelling; relatively cheap models used in parallel can greatly improve the efficiency of system modelling.

This gain can only be achieved, however, if the simple models are derived independently of each other (in much the same way as the failure of the second and third parallel components must be independent of the failure of the initial component). If the simple models are not independent of each other, then they will all contain the same errors and biases and hence the combined results of the simple models will be no better than the results from a single simple model. Finding suitably different models of the same process may require considerable thought.

TRANSPORT MODELLING TECHNIQUES

Irrespective of the complexity of the modelling process selected, there are four basic types of models used in transport policy analysis; supply, demand, costing and impact models. Supply models describe how the transport system operates physically. Demand models describe how potential users react to the operating characteristics of the system. Costing models estimate the financial cost of system operation to the operator. Impact models estimate the social, economic and environmental cost of transport system operation of the community.

Demand modelling is essentially concerned with understanding who will use a transport system under a variety of environmental and operating conditions. Over the past thirty years, a number of different types of demand model have been proposed and applied in the transport area. These models may basically be categorised into three groups:-

(i) First generation models - aggregate, predictive models which attempt to forecast traffic flows from origin to destination, by various modes, and along certain routes. These models are often called "four-step" models.

(ii) Second generation models - disaggregate, behavioural choice models based on theories of individual choice derived from the economic or psychology literature. These models assume that transport usage is based upon a function which incorporates the characteristics of the transport system, the user and the trip type. These models are typified by the multinominal logit model, and variations thereof.

(iii) Third generation models - disaggregate models which attempt to explain an individual's transport decisions within the context of his total activity-pattern decisions, and which take account of the social context and constraints within which an individual exists. These models have been developed over the last decade, primarily in Europe and Britain.

While each of these types of models is appropriate in different circumstances, this paper concentrates upon the collection of empirical data which can be used primarily in conjunction with third-generation demand models. Third generation demand models are distinguished by their concern for three essential elements; the nature of activities, the role of situational constraints, and the survey methods used to collect activity and situational data.

Third generation demand models assume that travel is just another activity, and as such must be placed within the context of surrounding activities and constraints. This placement of trips within an activity framework assists both in the collection of travel data and in the interpretation and understanding of traveller decision-making. These models also assume that individuals are not entirely free to choose travel options at will, but rather are constrained by the situations in which they exist. Examples of such constraints are the obligations of household members towards other members of the household, and generally towards other members of society. Arising from the above two factors is the need to use survey methods which will be able to capture the nature and extent of trip-making within an activity-based, situationally-constrained context. The use of methods generally known as interactive measurement has been espoused as the technique most capable of capturing travel information in these circumstances. In interactive measurement, group interviews are conducted with households and, in a relatively unstructured manner, their travel patterns and reactions to change are elicited within the context of total activity patterns (Brög and Erl, 1980; Carpenter and Jones, 1983).

## THE EAST PRESTON TRAMWAY EXTENSION PROJECT

To demonstrate the use of interactive measurement techniques within the context of third generation demand modelling, the Victorian Ministry of Transport commissioned SOCIALDATA Australia to apply these techniques to investigate changes in travel patterns arising out of the extension of the East Preston tram route. With this extension, the route for trams 88 and 14 is to be extended along Plenty Road from East Preston (Tyler Street) to the Preston Institute of Technology (terminating at McKimmies Road) in three stages. The first stage of this extension, terminating at Albert Street was finalised in June 1983; the second stage terminating at Latrobe University was due for completion in December 1984; the third stage has yet to be scheduled for completion.

The tramway extension could cause a number of different reactions. Patronage could be generated or attracted (with trip origins or destinations in the newly connected area); individuals could change modes (including access modes) or, as a consequence of the new service, change their activity patterns further; household members of those individuals could be affected in restructuring the activity patterns; households could change their place of residence with respect to accessibility to the new route; land use patterns in general could be adjusted to the new supply situation. The aim of the study was to investigate the likely significance of each of these possible reactions.

## CONCEPTUAL CONSIDERATIONS

The study of the East Preston Tramway extension in Melbourne required the use of several different methods to provide policy-relevant data. The goal of the study was to assess the potential use of the extension, and this was possible by examining the behavioural options of two groups of people - those who lived near the section of the tramline which had been extended just over a year ago, and those who lived near the section of tramline about to be completed. The first group, therefore, consisted of people who have already established travel behaviour patterns in response to a change in the physical system, and the second group of people who will do so in the near future. It should be noted that response to a change in the transport infrastructure can be in the form of use or non-use of the new mode. Knowledge about the reasons underlying both reactions is equally important from a policy viewpoint, if effective measures to influence change in behaviour are to be considered.

The area where the tramline has already been completed is the Reservoir area, while Kingsbury residents formed the basis for the sample of those persons to be affected in the future. In Reservoir it was necessary to have at least one person in the household who currently used the new tramline, to enable the study of the no-tram scenario.

## Obtaining A Sample Of Tram Users

The most efficient method of obtaining addresses of current tram users is either on-board or at-stop surveys along the relevant route. The experimental approach - a combination of both methods - was used, at the same time providing a kind of control measure. On-board interviews were self-administered but were handed out and collected by "interviewers". At-stop interviews were carried out personally by interviewers. The questionnaire design was similar in both cases, but minor differences in layout and design reflected the need for either respondent- or interviewer-friendliness as required.

It was shown that very high response rates could be achieved using both methods. Of all persons sampled, 93% responded to the questionnaire and 86% willingly gave their addresses. Since the mode used to make this journey prior to the new tramline was questioned, it was also possible to select the sample based on the type of mode change which had occurred.

The households selected for inclusion in the next stage of data collection - interactive measurement - were kept within 400 metres of a tram stop (or future tram stop) in both Reservoir and Kingsbury.

## Interactive Measurement as a Policy Tool

The technique of interactive measurement has been discussed in detail elsewhere (e.g. Brög and Erl, 1980; Brög, Erl, and Ampt, 1983) and involves the interaction of all persons in the household above a certain age (usually 10 years) in response to a wide spectrum of questions. Its primary use is as an integral part of a range of survey methods - e.g. self-administered, personal interview, indepth - and it is in this context that it was applied in the current study.

To gain valid, policy-related information, data were needed from which observed behaviour could be explained, and the potential to react to two scenarios could be gauged, as follows:

(i) For Kingsbury (no tram currently) for each trip for which it would be feasible to use the tram in the future, all relevant dimensions (e.g. time, distance, destination) were checked to establish the possibility of actual use of this mode; and

(ii) For Reservoir (where the tram is available), for each trip currently made by tram, all relevant dimensions were checked to establish possible alternative modes. This was done by asking respondents to imagine that the tram was not available for a long time period, and has been found to be a much more reliable way of collecting these type of data than by asking what modes were used before the introduction of the tram.

The information supplied in this way can be used, at a minimum, to describe the options and constraints of each household and person. In addition, the most appropriate measures to remove constraints can be readily identified.

## METHODOLOGICAL ASPECTS

### The Study Design

As noted above, the in-depth survey in the East Preston application included several survey methods.

#### Self-administered information

The person-related information was all gathered using self-administered questionnaire forms. The information included: -

(i) socio-demographic details;

(ii) actual travel behaviour; and

(iii) subjective perceptions of modes used, and alternative modes.

This method has the advantage that it is most accurate, that it reflects individual's (and not, say, parent's) perceptions, and that there is no interviewer bias. In addition, responses on these forms remain uninfluenced by other responses during the interview.

#### Personal interview (partially interactive)

Another stage of the interview is the measurement of the possibility of each individual using various transport modes. Initially, these options were studied in general, and not in relation to any particular trip. The goal was to establish to what extent a person perceived modes as usable and whether there were general reasons (e.g. health) which made use of some modes impossible.

Because of its relatively simple content, this section was particularly appropriate for the start of the interview. It was also administered interactively to accustom the respondents to the more involved interaction required later.

For each vehicle (including motor bikes and bicycles) in the household, each person had to say whether it was available to them 'practically always', 'practically never', or only 'under certain conditions'. In addition, respondents were asked whether they could generally travel as a car passenger, by walking, or with a bicycle.

The interviewer always asked each person to describe their situation exactly. In many cases this lead to a controversy between the household members; especially when a particular vehicle was available to several persons who had a different interpretation of the extent to which other people made use of their user's right. In all cases, however, the most important function of the interviewer at this stage was to draw the people in the interview out of the role of "passive information machines" into active participants.

To gain other types of information, it is important to observe the cooperation of individuals and their reactions to alternative aspects of the solution. Here the household unit is of vital importance and interactive measurement becomes vital. Using a visual layout which was easy to understand, respondents were able to see graphically first their actual situation, and then the impacts of changes - to themselves, and on other household members. In this way the structure of interpersonal relations or connections was made as transparent as possible. This eliminates the very speculative nature of results achieved when simple "what if" questions are directed at individuals rather than households. The scenario-approach used in the interactive measurement is described in the next section.

## The Scenario Approach

The aim of the study was to determine the potential for use of the new tramline (Kingsbury sample) by essentially simulating a "before" case in the Reservoir area. This was done by using the "tram scenario" in Kingsbury and a "no-tram scenario" in the Reservoir area. The details of this method are described in more detail in this section.

### The tram scenario - Kingsbury

Using the travel data collected in the first stage of the interview for an actual sample travel day, one respondent in the household was asked to reorganise his or her trips to include the use of the tram. This was only done for destinations where it was feasible. After this step, all other persons had to check if the changes to the first person's travel had any effect on their own behaviour (e.g. if the first person arrived home half an hour later because of using the tram, he/she may not have had time to do the shopping; and someone else may have had to do it). Then, the next person was asked to reorganise their trips, and so on.

All changes in travel times, destinations, in persons taking part in the activities, and in whether or not a trip actually took place were recorded in detail. In the cases where reorganisation was not possible, details were also recorded.

### No-tram scenario - Reservoir

Once again using the actual travel data from earlier in the interview, the person(s) who had made a trip by tram were asked to imagine that the trip was no longer possible by tram (the fictional collapse of a bridge was given as a reason). This person had to reorganise his/her day, and if it had impacts on other persons they were asked to reorganise their travel behaviour accordingly.

An example here can be used to illustrate the realistic nature of the technique and its ability to measure potentials accurately. When asked not to use the tram to travel to work, a father said he would take the family car. Then, when the mother was forced to reorganise her day without it, he realised the serious problems she would face and decided that he would walk 10 minutes further each morning and night to take the train to work and back. This type of reaction would not have been measured in a less sensitive technique.

There were many reactions to the scenarios:

(i) an earlier start to the trip (in general only readily possible for the first trip of the day);

(ii) later arrival at the destination (only possible if work times were not fixed, not generally possible for work/eduation trips, doctor's appointments, etc.);

(iii) reduction of the stay at the destination (similar limitations to later arrival);

(iv) a change in mode;

(v) destination substitution (the current destination was substituted by another at which the same activity could be carried out - not possible for work and education trips);

(vi) person substitution (the activity was done by someone else, since the new travel times no longer fitted into the current activity pattern); and

(vii) change in the activity chain (e.g. two activities which were previously independent were combined, thereby saving one trip and possibly compensating for the increased duration).

The wide spectrum of reorganisation which was possible meant that the most accurate possible description of potential situations within all households could be described.

## ANALYSIS

### Initial Stages

The preparation for analysis of these type of data is necessarily comprehensive so that the multi-faceted data gathering approach can be fully appreciated. Processing which does justice to the extent of the data cannot be done simply by requesting innumerable single pieces of information in a purely technical manner. The initial phase of recreating the household situation from both a subjective and objective point of view cannot be done by a computer. The contradictions which occur within a households situation or 'within' an individual, and which are so common in reality cannot be dealt with in this way if meaningful, policy-oriented data are to result.

First, every fact reported in the interview needs to be analysed at the level of the individual. Contradictions and subjective misappraisals (e.g. of distance or cost) cannot simply be eliminated - it could be precisely these elements which are the reason for a particular behaviour. Consequently, for every interview, a fundamental, individual case analysis is undertaken. The individual case analysis, therefore, is not a point by point coding process, but it is a basic reading of all the information available about the household, thereby giving a concrete picture of the household's situation, so that the coders can effectively "put themselves in the household's shoes". Only after this step can the preparation of the data for computer processing take place.

### The Situational Model

On the basis of the multi-phased approach described in this paper, it is possible to get a complete picture of the behavioural options for mode choice and of the specific character of these options for each trip in Reservoir and Kingsbury - for the existing situation and for the appropriate scenario. This task is not quite as difficult as may be imagined. Due to the very comprehensive nature of the approach, and the equally comprehensive documentation of all of the components of an individual's behavioural options, the interview results basically act as a surrogate for the household itself. Using this kind of survey instrument, the individual reasons for specific behaviour are readily apparent in most cases, even when several reasons are interrelated.

The more difficult aspect of analysis is trying to translate the actual reasons into an analytical framework suitable for all cases. The framework for analysis consists of the dimensions of the situational approach. These situationally determined variables are derived on the basis of the thorough perusal of the completed questionnaires. One of the essential elements of this final phase is the determination of whether given constraints or options are always important or whether they are important only under special conditions (e.g. bad weather). This allows the final results to be even more accurately related to the real-life situation where some people may be able to use the tram always, and some only under special conditions (e.g. when it is not necessary to carry equipment to work).

The seven situational groups which result provide a filtering mechanism whereby the realistic potential for use of the tram may be assessed, and where the reasons for non-use of the tram may be highlighted.

## Results

Interactive interviews were conducted in 127 households; 51 in Reservoir and 76 in Kingsbury. These interviews involved 139 household members in Reservoir and 162 household members in Kingsbury. Because of the different sampling methods employed in each area (each household sampled in Reservoir had a tram user, while households in Kingsbury were randomly selected), the sociodemographic characteristics of the households in each area sample were substantially different. For example, the average age in the Reservoir sample was lower, the percentage married was lower, licence holding was lower, car ownership was lower, and obviously public transport usage (especially tram) was higher in Reservoir.

Preliminary results relating to the situational dimensions, as obtained from an initial analysis, are summarised in aggregate form in Table 1. The results in this table depict the aggregate response to questions on the various dimensions with respect to the use of public transport in general for all trips on the sample travel day currently not made by public transport. For example, 12.1% of Reservoir respondents stated, and discussed, that there were constraints which would make the extra use of public transport impossible. Similarly, 17.4% of Reservoir respondents judged that the comfort of public transport modes would prevent them from using public transport. Whilst Table 1 is a useful summary of responses, it does not provide a complete picture of the degree to which the various dimensions are a constraining influence on the potential extra use of public transport. To examine this requires that the results be expressed in the form of decision trees based on the situational dimension responses. Such decision trees are shown in Figure 3.

TABLE 1. AGGREGATE DIMENSIONS WITH RESPECT TO ALL PUBLIC TRANSPORT.

| SITUATIONAL DIMENSION | RESERVOIR | | KINGSBURY | |
|---|---|---|---|---|
| OBJECTIVE OPTION<br>Is there an objective option to use public transport? | YES<br>NO | 26.2%<br>73.8% | YES<br>NO | 75.4%<br>24.6% |
| CONSTRAINTS<br>Are there constraints which make use of public transport impossible? | YES<br>NO | 12.1%<br>87.9% | YES<br>NO | 15.4%<br>84.6% |
| INFORMATION<br>Are they informed about public transport? | YES<br>NO | 56.4%<br>43.6% | YES<br>NO | 36.3%<br>63.7% |
| TIME<br>Is time evaluated or perceived positively/correctly? | YES<br>NO | 87.5%<br>12.5% | YES<br>NO | 81.4%<br>18.6% |
| COSTS<br>Are costs evaluated or perceived positively/correctly? | YES<br>NO | 100%<br>0% | YES<br>NO | 99.8%<br>0.2% |
| COMFORT<br>Is comfort evaluated or perceived positively/correctly? | YES<br>NO | 82.6%<br>17.4% | YES<br>NO | 72.7%<br>27.3% |
| SUBJECTIVE WILLINGNESS<br>Is there a subjective willingness to use public transport? | YES<br>NO | 86.6%<br>13.4% | YES<br>NO | 88.0%<br>12.0% |

The difference between the results in Table 1 and Figure 3 is that while Table 1 shows aggregate results, Figure 3 shows conditional responses at each level. For example, 12.1% of all Reservoir respondents stated that they had constraints making the extra use of public transport impossible, whereas only 6.1% (i.e. 1.6/26.2) of those with an objective option available faced similar constraints. Because of the conditional nature of the responses in Figure 3, the figures on the right branch of each tree show the percent who still have the option of using public transport. The bottom line in each tree shows the potential extra market for public transport in each area. This is not to say that these people will use public transport; all it says is that they have not rejected the use of public transport on the basis of the seven situational dimensions listed. Whether they will use public transport will depend on the relative levels of service provided by public transport and other competing modes. At this stage, second generation demand models may be useful in predicting the probability of usage.

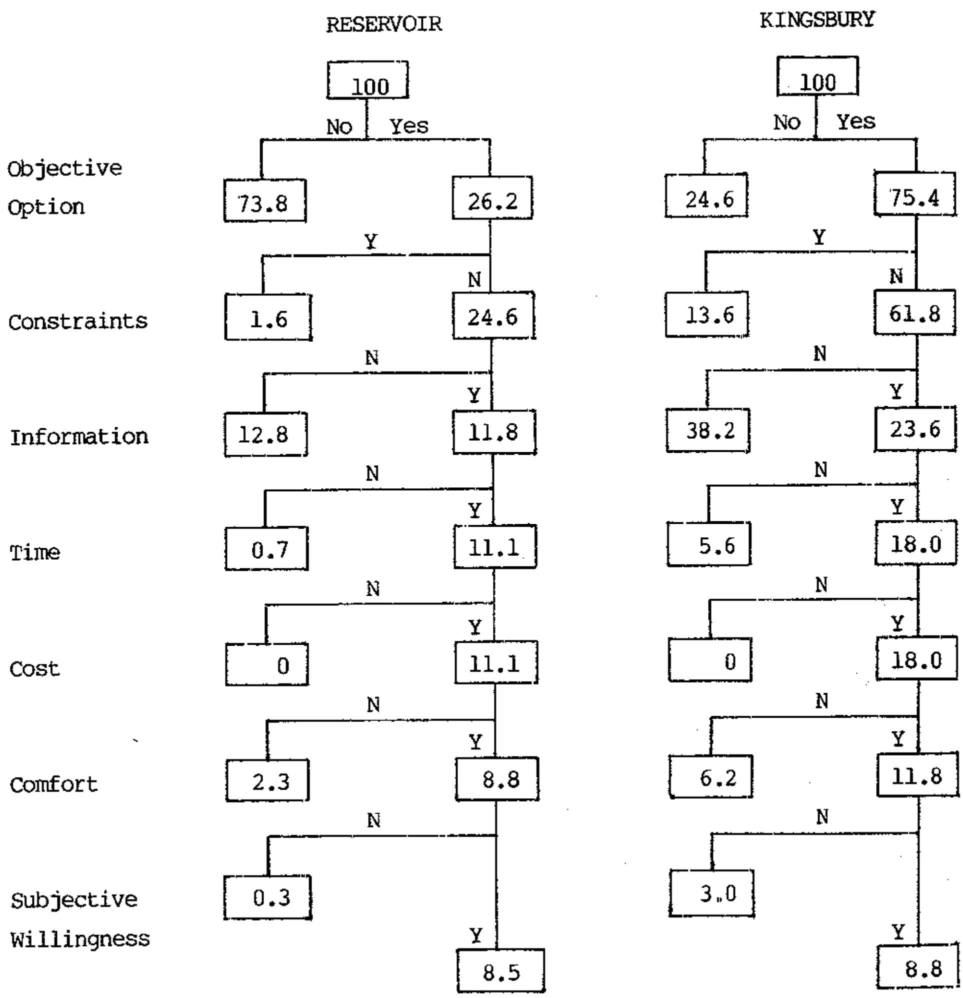


Figure 3. Options for Using Public Transport in Reservoir and Kingsbury.

Interestingly there appears to be a constant value of 8 to 9 percent of the population in both Reservoir and Kingsbury who see public transport as a viable potential mode for trips currently not made by public transport. However, the reasons given by the other 91 to 92 percent of the population for not using public transport are substantially different.

In Reservoir, 73.8% of the sample said that public transport was not an objective option for any of the trips which they had made on the travel sample day by modes other than public transport, whereas only 24.6% in Kingsbury gave this response. This is understandable in view of the fact that 34% of current trips in Reservoir are already made by public transport whereas only 8% of trips in Kingsbury are by public transport. Where an objective option exists this opportunity has already been utilized in Reservoir.

However while there is a greater objective available of public transport in Kingsbury for mode switching, this potential is whittled down by a number of other factors. Kingsbury residents face more constraints on usage, are much less well informed about opportunities for usage, are more deterred by time and comfort considerations and have a greater subjective disposition against using public transport. The end result is that there is currently about the same potential for extra public transport trips per head among the existing users in Reservoir as among the non-users in Kingsbury.

Significantly, there is no one in either Reservoir or Kingsbury who perceives cost to be a deterrent to usage of the system. This confirms the findings of many other studies which show the relative unimportance of cost as a determinant of public transport usage.

When attention is confined only to potential usage of the tram extension in Kingsbury, one sees that there is a lower potential for usage as shown in Figure 4. The primary reason for this lower potential is simply the lower objective availability of the tram for trips from Kingsbury. Quite naturally there are some trips which could be made by other public transport modes but not by tram.

Whilst the above discussion describes why public transport is excluded from consideration as a viable potential mode, it does not show what the most effective courses of action might be to increase the viability of public transport in these areas. To do this requires the calculation of indices of efficiency for each of the dimensions. This is done by relaxing the constraint imposed by each measure in turn, and then observing the effect of this relaxation on the bottom-line public transport potential. The results of these calculations are shown in Table 2.

For example, if public transport were to be made an objective option for all trips in Reservoir one could expect that the potential for public transport trips would increase to 229% of its current level (i.e. 8.5 x 2.29 = 19.5%). It can be seen that for general public transport in Reservoir and Kingsbury, the provision of more and better information about the available services would result in the greatest increase in public transport potential. For the tram extension in Kingsbury, information is the second most effective measure behind making the tram more of an objective option. It must be realised, however, that these indices of efficiency are not measures of cost effectiveness. It will obviously be much more expensive to make the tram an objective option for all trips than it would be to provide information about the current system.

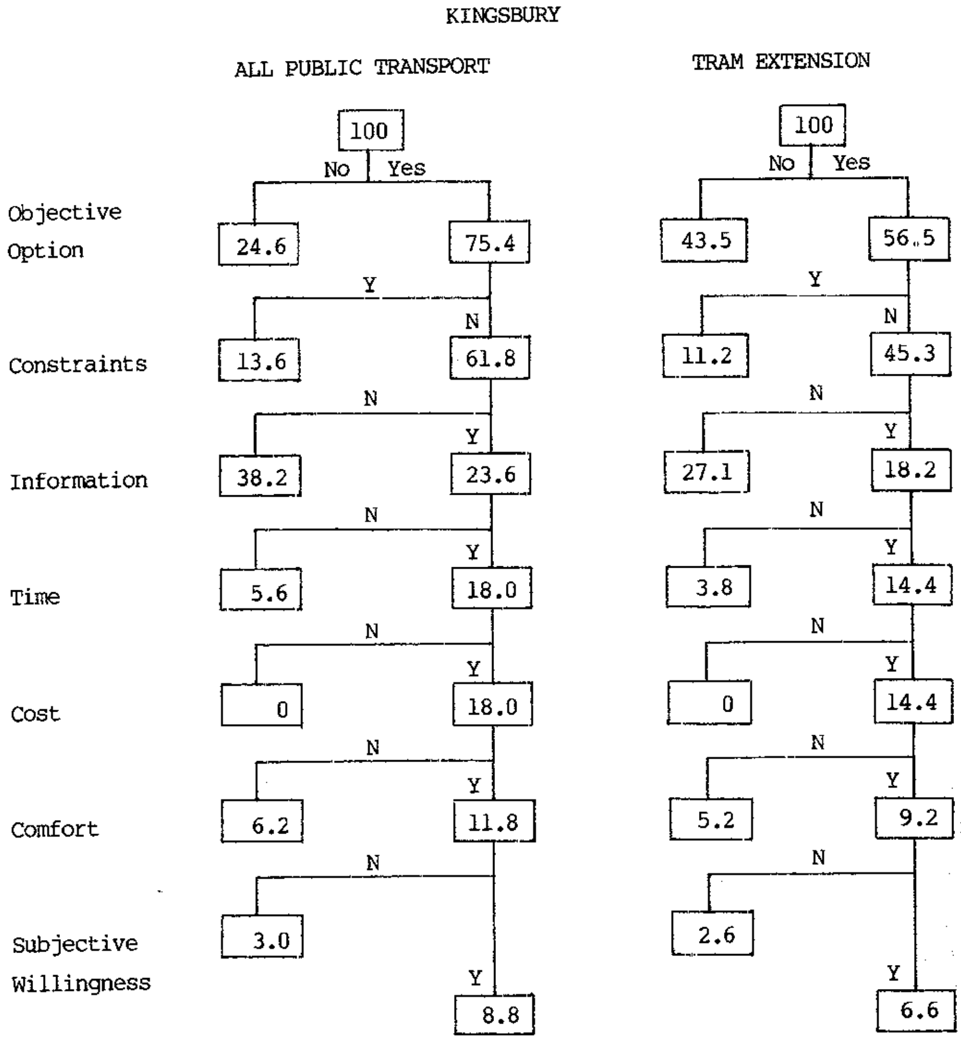


Figure 4. Options for Using All Public Transport and the Tram Extension in Kingsbury

TABLE 2. INDICES OF EFFICIENCY OF MEASURES

| | RESERVOIR | KINGSBURY | |
|---|---|---|---|
| | All P.T. | All P.T. | Tram Extension |
| Status Quo ⟶ | 8.5% ≡ 100 | 8.8% ≡ 100 | 6.6% ≡ 100 |
| Objective Option | 229 | 172 | 314 |
| Constraints | 152 | 127 | 118 |
| Information | 247 | 244 | 189 |
| Time | 130 | 139 | 106 |
| Cost | 100 | 100 | 100 |
| Comfort | 176 | 167 | 125 |
| Subjective Willingness | 139 | 134 | 104 |
| Information and Subjective Willingness | 341 | 335 | 220 |

The use of indices of efficiency allows for policies to be evaluated in various combinations. For example, if a publicity campaign were able to both provide information and change people's willingness to use public transport then the potential for all public transport could be increased by 241% in Reservoir and 235% in Kingsbury. Testing policies in combination in this way enables the identification of those policies which are complementary and those which are overlapping.

Three provisos need to be stated re the use of these indices. First, it is unlikely that any policy will reduce the degree of constraint imposed by any dimension to zero, and hence allowance should be made for less than complete effectiveness of any policy. Secondly, the increase is only in the potential use of public transport; actual use of public transport will depend on the relative attractiveness of public transport with respect to other viable modes. Thirdly, as noted earlier, one needs to consider the cost involved in removing any or all of the constraint associated with a dimension, so that a measure of cost effectiveness can be estimated for each of the dimensions.

## CONCLUSIONS

This paper has argued that a balanced approach needs to be taken to the use of empirical data and theoretical models when attempting to provide transport policy advice. Using a case study concerning the extension of a tram route in Melbourne, the techniques of interactive measurement and situational analysis have been described and used to assess the potential for increased public transport trips in two areas along the extension. Situational analysis has also been used to demonstrate the efficiency of various policies in attempting to increase the potential for public transport use. The analysis reported in this paper draws on only a subset of the data collected in this project and makes no recourse to the data collected by means of the tram/no-tram scenario approach. Nevertheless, the approach described in this paper has exemplified a methodology which traverses a wide spectrum of data collection and channels all data into fairly powerful, easy-to-understand, policy-specific results. It has emphasised the interactions which occur within households and within the individual decision making process, while highlighting the advantages for policy making of the results achieved in this way.

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