THE ROLE OF STATED PREFERENCES AND DISCRETE- CHOICE MODELS IN IDENTIFYING INDIVIDUAL PREFERENCES FOR TRAFFIC-MANAGEMENT DEVICES

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SUMMARY

Responsible local governments recognize the need to be sensitive to the local environmental implications of decisions taken in the course of developing strategies to ensure the efficient use of scarce resources. Rather than rely on the pressures of lobby groups to direct government behavior in relation to community concerns, a preferred strategy is to identify the preferences and choices of the community as a whole and to use information from a representative cross-section of the community to aid in making environmentally-linked decisions that maximize the benefits to the affected community. This paper demonstrates how discrete-choice models can be used to identify community choices among alternative traffic-management devices designed to improve the traffic environment within and in the vicinity of local residential streets. Using a “before” and “after” survey strategy, the study provides evidence to support the view that a set of guidelines representing the community's preferences for different devices should be based on an empirical model estimated on a sample of residents who have already had exposure to a range of devices.

INTRODUCTION

More and more local governments are becoming sensitive and responsive to community concerns that identify the impacts of outcomes linked to decisions taken by them. Often, the concerns expressed by community groups are strongly influenced by a vocal minority who may not represent the views of the silent majority. While recognizing concerns expressed by lobby groups, it is important to establish the extent to which such views are associated with the community as a whole. One way to establish symbiosis is to develop a set of procedures to determine the preferences and choices of a representative sample of community members with respect to the issue of concern.

This paper demonstrates how discrete-choice models can be combined with conjoint-choice data obtained from a sample of residents, to identify community choices between alternative ways of improving the traffic on sub-arterial roads that pass through local areas. Such traffic is attributable to decisions regarding the location of residences, offices, factories, and retail outlets. The approach represents an appealing method to assist local government in responding to the complaints of the vocal minority, so that effective decisions on environmental matters will be consistent with the needs and concerns of the population as a whole.

This paper presents the findings of a “before” and “after” study (two-wave panel) of community preferences and attitudes towards alternative traffic-control devices in the Willoughby Municipality, within the Sydney metropolitan area. Many sub-arterial roads are predominantly residential streets. Typically levels of traffic on many sub-arterial roads normally would be associated with major arterial roads (including freeways). Such devices become necessary when traffic from major arterial roads is diverted into residential areas to avoid congestion. This creates problems for the local residents such as increased exposure to risk, higher noise levels, and a deterioration in the quality of residential life. As a result of such developments the Willoughby Council decided to introduce small roundabouts, midblock islands, and thresholds into three residential streets. The traffic-control devices combine to form a scheme that is referred to as Sub-Arterial Traffic Management (SATM). It is designed to improve the safety of the sub-arterial residential streets by reducing the maximum speed of traffic and the variability of speed along a road. These aims must not be achieved at the expense of filtering traffic into local residential streets.

The study was undertaken in two parts. First-stage interviews were conducted before the installation of SATM devices with a follow-up survey of the same residents after the scheme was completed. The "before" study identified the particular devices and schemes the community found to be preferable. An "after" study evaluated community reaction to the installation of the individual devices. This approach represents an appealing method to planners, because it involves the local community in the decision-making process and helps to minimize their fears about the scheme, enabling local government to plan with, rather than simply for, the local community. It also avoids the need for planners to try out various schemes. The savings in scarce resources and image are substantial.

Defining a Community Preference Study

Any plan to improve the local traffic consequences of the locational decisions of an activity supported by local government requires careful assessment of both the benefits and costs. Benefits are primarily reductions in mean speeds, variability of speeds along the road, and reductions in noise levels. The main costs are actual outlays on installation and maintenance. A number of well-tested traffic-management devices can combine to define a SATM scheme, each of which has different speed, noise, and cost implications. Our task is to establish a mechanism for measuring preferences of the affected communities, and hence their choices in relation to alternative devices and possible combinations of devices (i.e., schemes). The devices considered by local government traffic engineers are small roundabouts, mid-block islands, and thresholds.

To investigate the community impacts of alternative devices and schemes, we undertook the initial "before" study as a basis for identifying community preferences for alternative devices. The knowledge obtained from this first phase was used together with engineering considerations to assist the traffic engineers and municipal planners in the selection, design, and placement of a number of devices along three busy sub-arterial roads in the Willoughby Municipality.

Three devices and four SATM schemes were proposed. We sought to measure individual preferences for these schemes using a survey instrument in which residents evaluated different devices and schemes. A rating scale was used to obtain a metric measure of relative utility. This scale can be transformed into a choice index in a number of ways. Ratings can be approximated by rankings (including ties), treated as ordinal categories, and/or the highest actual or predicted rating treated as a first-preference choice. These alternative-ratings transformations can be analyzed at the individual or group level. The former generates choice probabilities, the latter generates choice proportions. We use the highest rating as the first-preference choice, and use the multinomial-logit technique to model these preferences.

Attributes	**Levels**	**Definition**
Before and After		
Speed at Device	**3**	**20kph, 45kph, 70kph**
Speed 100 meters from Device	**3**	**30kph, 55kph, 80kph**
Noise Level at Device	**3**	**More, Same, Less**
Source of Funding	**3**	**Council, State Government, Rates Increase**
After Only		
Speed at Device	**3**	**20kph, 40kph, 60kph**
Speed 100 meters from Device	**3**	**40kph, 60kph, 80kph**
Noise Level at Device	**3**	**More, Same, Less**
Source of Funding	**3**	**Council, State Government, Rates Increase**

The results of studying the choice among the four schemes in the “before” survey are reported in Hensher[1]. In this paper we concentrate on the choice of devices *per se*. This emphasis is chosen for a number of important reasons. First, given that one objective is to assist the Roads and Traffic Authority of NSW in the preparation of some guidelines on the way community preferences and attitudes can be used in the process of selecting SATM schemes, it is necessary to treat each device in a way that enables us to evaluate the community's preferences for all possible combinations of devices. The emphasis on a limited number of schemes (as reported in Hensher[2]) is a significant constraint on the transferability of information to settings in which other combinations of devices may be more appropriate either from a community view point, or from an engineering perspective, or both.

We recognized this limitation in the “before” study and made provision for an investigation of devices *per se* by having two preference experiments: one for devices *per se* without any reference to specific siting locations, and one for specific schemes that were combinations of devices positioned at actual locations in the Willoughby Municipality. Schemes *per se* are extremely difficult to assess without reference to particular device placements; whereas devices can be evaluated with or without reference to specific locations. This is important for the "after" study, which is interested in evaluating both the community responses to schemes actually introduced, some of which are not one of the four schemes evaluated in the "before" study, and the transferability of responses to devices *per se*, the latter enabling us to evaluate a large number of schemes.

Hensher and Battellino[3] have shown by a nested-logit model that there is no meaningful relationship between the probability of choosing devices and the probability of choosing schemes conditional on device. The empirical assessment of the linkage between scheme choices and device choices involved the estimation of a nested-logit model in which the lower level represents the choice among schemes conditional on a device being present in the scheme, and the upper level represents the choice among devices. The relative utility associated with a device was found to be statistically independent of the scheme configuration containing the device.

It is generally accepted that each device has a logical positioning in a sub-arterial traffic-management scheme that is primarily determined by road design. If we can establish empirical evidence, from a comparison of the "before" and "after" responses, that enables us to conclude that the preferences for devices expressed prior to the introduction of particular devices in schemes are not statistically significantly different to the community preferences after the introduction of the devices, then we are in a very good position to set out empirical guidelines without having to undertake substantial new surveys of community attitudes and preferences.

The Preference Experiment

A preference experiment specified in terms of four attributes was used to define each traffic management device. The attributes were 1) traffic speed at the device, 2) traffic speed 100 meters from the device, 3) noise level at the device, and 4) the source of funds to pay for the facility. Each of the attributes had three levels (Table 1); a full factorial would require 81 combinations of attribute levels. An orthogonal, main- effects fraction generated a sample of nine alternatives. This design limits us to estimates of main effects. The final set of nine devices selected from the full factorial treatments reduced to six per device in the "before" survey and eight per device in the "after" survey, after allowing for dominance. The "before" and "after" designs are identical with respect to the fractional factorial design; however the "after" study used two sets of levels of the attributes. These are given in Table 2 for the design common to both surveys and in Table 3 for the "after" survey only. One set was identical to the "before" study, while another set was substantially different.

This enabled us to investigate the presence or absence of any systematic differences in responses due to the combinations and levels of attributes. The “after” sample was a subsample of the “before” sample, limited to the residents living on or close to the streets subject to the SATM treatment.

Each respondent who participated in the “before” study with a fixed design was randomly assigned to one of the “after” experiments and two sets of device cards representing particular levels of each attribute for each device. They rated each description of each device on a 10 point scale. The experiment was administered as a personal interview.

Budget constraints prevented us from re-surveying the sample of residents within the Willoughby Municipality who are not local or close-by residents. The “before” study had shown, however, that location was not a statistically significant influence of one’s attitudes to devices. This is an encouraging finding for a study concerned with the temporal and spatial transferability of community preferences towards SATM devices. In addition, the “after” study exposed each respondent to two replications of the device experiment, whereas the “before” study administered only one replication.

THE SURVEY STRATEGY

The “after” survey took place in February, 1991, 18 months after the “before” survey. In the “before” survey the Willoughby Municipality was divided into three sub-populations:

Local:	all residents in streets where SATM was proposed to be installed,
Close-by:	those residents in streets surrounding the three local streets;
Remaining:	all other residents in the Municipality.

Card	Device	Cost	Paid by	Speed at Device	Speed Between	Impact on Noise
R01	Roundabout	$7,000	Council	45kph	80kph	Same
R02	Roundabout	$7,000	Council	20kph	55kph	More
R03	Roundabout	$7,000	State Govt.	45kph	55kph	Less
R04	Roundabout	$7,000	State Govt.	20kph	30kph	Same
R05	Roundabout	$7,000	State Govt.	70kph	80kph	More
R06	Roundabout	$3.00	Rates Increase	20kph	80kph	Less
M01	Midblock	$5,000	Council	45kph	80kph	Same
M02	Midblock	$5,000	Council	20kph	55kph	More
M03	Midblock	$5,000	State Govt.	45kph	55kph	Less
M04	Midblock	$5,000	State Govt.	20kph	30kph	Same
M05	Midblock	$5,000	State Govt.	70kph	80kph	More
M06	Midblock	$2.50	Rates Increase	20kph	80kph	Less
T01	Threshold	$4,000	Council	45kph	80kph	Same
T02	Threshold	$4,000	Council	20kph	55kph	More
T03	Threshold	$4,000	State Govt.	45kph	55kph	Less
T04	Threshold	$4,000	State Govt.	20kph	30kph	Same
T05	Threshold	$4,000	State Govt.	70kph	80kph	More
T06	Threshold	$2.00	Rates Incraese	20kph	80kph	Less

Card	Device	Cost	Paid By	Speed at Device	Speed Between	Impact on Noise
R11	Roundabout	$7,000	State Govt.	40kph	80kph	Same
R12	Roundabout	$7,000	State Govt.	20kph	60kph	More
R13	Roundabout	$3.00	Rates Increase	40kph	60kph	Less
R14	Roundabout	$3.00	Rates Increase	20kph	40kph	Same
R15	Roundabout	$7,000	Rates Increase	60kph	80kph	More
R16	Roundabout	$7,000	Council	40kph	40kph	More
R17	Roundabout	$7,000	Council	20kph	80kph	Less
R18	Roundabout	$7,000	Council	60kph	60kph	Same
M11	Midblock	$5,000	State Govt.	40kph	80kph	Same
M12	Midblock	$5,000	State Govt.	20kph	60kph	More
M13	Midblock	$2.50	Rates Increase	40kph	60kph	Less
M14	Midblock	$2.50	Rates Increase	20kph	40kph	Same
M15	Midblock	$2.50	Rates Increase	60kph	80kph	More
M16	Midblock	$5,000	Council	40kph	40kph	More
M17	Midblock	$5,000	Council	20kph	80kph	Less
M18	Midblock	$5,000	Council	60kph	60kph	Same
T11	Threshold	$4,000	State Govt.	40kph	80kph	Same
T12	Threshold	$4,000	State Govt.	20kph	60kph	More
T13	Threshold	$2.00	Rates Increase	40kph	60kph	Less
T14	Threshold	$2.00	Rates Increase	20kph	40kph	Same
T15	Threshold	$2.00	Rates Increase	60kph	80kph	More
T16	Threshold	$4,000	Council	40kph	40kph	More
T17	Threshold	$4,000	Council	20kph	80kph	Less
T18	Threshold	$4,000	Council	60kph	60kph	Same

In the “local” population all residents living in those streets were included in the sample. In the” close-by” and “remaining” populations, residents were randomly sampled from randomly-selected blocks. The “before” survey of 201 residents comprised 100 “local” residents in the streets where the devices were placed; 60 “close-by” residents who live in streets close to the these streets; and 41 respondents from the “remaining” population of the Municipality. In the “after” study, only residents in “local” and “close-by” populations were interviewed. Of the 160 respondents in these categories in the “before” survey, 116 residents were reinterviewed. Response rates for both stages were high, indicating a strong interest in the community in traffic-management schemes. The response rate in the “after” survey was 73 percent. All of the other 27 percent of residents were accounted for, with 17 percent (27 respondents) who had moved or been on holiday at the time of interview, 7 percent (11 respondents) who could not be located either by the interviewer having a wrong address or after a number of call backs, 3 percent (five respondents) refusing to do the survey and 0.6 percent (one respondent) having died. Fifty-five percent of the two-wave sample (64 respondents) lived in a street in which devices were located.

The survey contained questions on:

1. The respondent's perception of the level of traffic in his or her street;

2. The respondent's general perceptions and attitudes towards the overall scheme of devices proposed and then installed;

3. Attitudes towards a particular roundabout, midblock and threshold with which the respondent is familiar, concerning the effectiveness of the device, safety, aesthetics, and noise levels;

4. A stated-preference experiment requiring the respondent to evaluate each of the selected devices in terms of the cost, source of funding, speed at the device, speed after leaving the device, and noise level;

5. In the “before” survey only, device combinations were evaluated as particular schemes;

6. Socioeconomic and demographic data on the resident such as income, years living in the Municipality, household size and composition, occupation, and vehicle ownership.

The “after” questionnaire contained many questions common to the “before” questionnaire to enable a “before” and “after” analysis of respondents’ opinions. However, a number of important changes were made. Questions about the resident’s general perception of traffic conditions in his or her street were replaced with questions relating to the reactions to the scheme of devices that had been put in place and its impact on traffic flows. These included opinions on the advantages and disadvantages of the scheme overall, the respondent’s overall opinion of the scheme, questions concerning the actual devices through which the respondent travels or avoids, and perceptions of the speed of the traffic travelling both between and through, the devices. Details of these results are reported in Gee et.al[4]. After the devices were in place, the questions about attitudes to types of devices were based on three particular devices — one roundabout, one midblock and one threshold — with which the respondent was familiar. The main descriptive findings from the attitudinal questions in the “after” survey are[5]:

(i) Sixty-one percent of the respondents were pleased with the in-place scheme overall.

(ii) The scheme had succeeded in reducing speed and increasing safety, but not in reducing the volume of traffic. There did appear to be some negative spin-off into an adjacent street.

(iii) Respondents generally found devices to be visually attractive, with landscaping being an important requirement. Some disapproved of the strong color used on the threshold in one of the roads.

(iv) There was a concern expressed that the devices should have better lighting, because they are difficult to see at night.

(v) Thresholds were seen as being the least effective, because those installed are not narrow enough to slow traffic.

(vi) The main advantages of devices were reduced speed and increased safety.

(vii) The majority of residents still believed that the spending of the Council's money was justified.

(viii) The majority of residents found no disadvantages with the scheme.

(ix) Some residents expressed concern that motorists did not know how to use the devices correctly, and that driver education is necessary.

Analysis of the Stated-Preference Experiment

The conjoint-choice data were transformed into a first-preference response (choice) set with the highest rating assumed to be the most-preferred alternative. The unit of analysis is an individual respondent, each respondent had a choice set of three devices. The multinomial-logit technique[6] was used to obtain parameter estimates for both design variables and the covariates.

Discrete-choice methods such as multinomial logit or probit estimated on individual data require the differencing on the attributes to be the **chosen minus each and every non-chosen**. Combined with the natural correlation in the real world of certain attributes, such as speed at devices that cannot plausibly be greater than speed between devices, maintenance of design orthogonality is difficult. One tries to minimize correlations resulting from differencing by using fractional factorial designs. Hensher and Barnard[7] illustrate the difficulty of retaining design orthogonality when individual-choice data (in contrast to aggregate-choice proportions) are used to estimate discrete-choice models. The attribute differencing problem can be circumvented by aggregating data over replications either within or across individuals, and analyzing choice frequencies[8,9,10].

The primary purpose of the discrete-choice model is to investigate the extent of transferability of community preferences identified from the “before” data base to situations that will exist after the implementation of devices. By comparing the results from the “after” study with the “before” study we can establish the extent to which a once-off “before” study is able to provide reliable information on community preferences towards SATM devices. If the transferability evidence is positive, then future SATM studies can be guided by community attitudes at the stage of evaluating alternative SATM strategies, to ensure that the selected devices (and schemes) are those that will receive greatest community support.

The following empirical approach was implemented to evaluate the transferability potential of community preferences for SATM devices:

1. The “after” model for choice of devices was estimated and used as the basis for determining community preferences. Three “after” models were

estimated: (i) for the entire sample, (ii) for the sample of residents asked to respond to combinations of attribute levels identical to the levels administered to the "before" sample, and (iii) for the sample of residents asked to respond to the new attribute levels.

2. The "before" model was estimated using the specification of the "after" model. Three "before" models were also estimated: (i) for the entire sample, (ii) for the sample of residents who participated in the "after" study, and (iii) for the sample of residents who did not participate in the "after" study.

The segmentation of the sample, according to participation in the two surveys and the administered attribute levels in a common experimental design, provides an important basis for establishing confidence in the results in respect of sampling strategy and attribute-level specification. Both of these dimensions are potential sources of bias in transferability of community preferences.

The literature on transferability is extensive[11]. In the current context, there is one "test" worthy of consideration. It involves a comparison of the marginal effects and the choice elasticities with respect to the design attributes, especially speed at the devices and speed 100 meters from the devices. Greene[12] suggests that the parameter estimates from a discrete-choice model are in themselves uninformative and, thus, direct comparisons of the absolute magnitudes of a given attribute between models is not very useful. A more appropriate basis of comparison involves the application of the parameter estimates in the derivation of the marginal effects and the choice elasticities. Because the marginal effects and the choice elasticities are related to each other, where the particular device attribute is continuous (notably the two speed variables), it makes good sense to use the elasticity measure as the basis for establishing the transferability potential of community preferences. The marginal effects can be used where the attributes are dichotomous (namely the level of noise and "who pays").

Formally, the marginal effect of an attribute is a measure of the effect of the particular attribute on the probability of choosing a particular device P_j, holding all other influences constant, and algebraically is given by:

$$dP/dx_j = P_j (1 - P_j)\, b$$

where,

j = 1,...,3,
x_j = level of design attribute, and
b = parameter estimate associated with x_j.

The (direct) elasticity of the probability of choosing a device with respect to an attribute is defined as the percentage change in the probability of choosing the device divided by the percentage change in the attribute level. Formally, this is defined as $DE_j = x_j (1-P_j)b$ and all other terms are as defined above. Note that the marginal effect and the device-choice elasticity are related; the marginal effect is $DE_j * P_j / x_j$.

Major Empirical Results

The empirical evidence on device-choice elasticities and marginal effects are summarized in Tables 4, 5, and 6 for the six applications contexts, together with the models from which they were derived. Table 4 presents the results of the models[13]: three "before" models and three "after" models. The base model is in the final column, being the entire sample from the "after" survey. Table 5 presents the means and standard deviations of the Marginal Effects. Table 6 gives the means for the Device-Choice Elasticities and Choice Probabilities. Pseudo-r squared measures the overall explanatory power of the models. Best practice suggests that a value between 0.2 and 0.4 is a good explanatory model[14].

Prior to comparing the six models, it is important to discuss the base model for the "after" situation, because all the other models have been estimated on the same set of attributes, with differences due to sample composition and attribute levels. The device-choice model tells us that given the cost, the speed at the device and 100 meters from a device, and noise levels around the device, we are able to identify the predisposition of the community towards supporting one or more devices. This is identified in terms of the device(s) providing the greatest level of relative satisfaction to each sampled member of the community, who in total represent the population from which they were sampled. This knowledge is important in the determination of community support for future plans to introduce devices both within the locational context actually studied and possibly in other locations.

Attribute	Stage I "Before"			Stage II "After"		
	Both Stages	Stage I Only	Full Sample	Old Design	New Design	Full Sample
Council Pays (M)	0.0407*	0.0379*	0.0082*	-0.087	0.0277*	-0.1338
	0.0208	0.0261	0.0033	0.0471	0.0176	0.0823
Council Pays (R)	0.0448*	0.0464*	0.0078*	-0.086	0.0295*	-0.1302
	0.0173	0.0194	0.0038	0.0465	0.0158	0.0833
Council Pays (T)	0.0412*	0.0441*	0.0074*	-0.085	0.0296*	-0.1213
	0.0215	0.0233	0.0045	0.0471	0.0168	0.0835
Less Noise (M)	0.2879	0.3311	0.1910	0.3126	0.4094	0.2259
	0.1469	0.2279	0.0771	0.1686	0.2606	0.1390
Less Noise (R)	0.3335	0.2244	0.4206	0.2545	0.3284	0.2627
	0.1287	0.0937	0.2047	0.1378	0.1759	0.1681
Less Noise (T)	0.2310	0.2882	0.1729	0.2627	0.2176	0.3923
	0.1201	0.1525	0.1041	0.1452	0.1236	0.2700
Personal Inc (M)	-0.00017*	-0.0003	0.00007*	0.00030	0.0005	0.0001*
	0.00009	0.00022	0.00004	0.00016	0.0003	0.00006
Dangerous Landscaping (M)	-0.1077*	-0.0797*	-0.2115	-0.3519	-1.827*	-0.4523
	0.05497	0.05486	0.08534	0.1898	1.163	0.2783

Notes: Mean and standard deviation are given for the al effects;
Items starred (*) are derived using parameter estimates which are not statistically significant

Attribute	Stage I "Before"			Stage II "After"		
	Both Stages	Stage I Only	Full Sample	Old Design	New Design	Full Sample
Device Specific	0.776	-1.738	-0.6470	-0.3859	0.9480	0.2460
Constant for M/block	0.59	-1.23	-0.72	-0.29	0.52	0.24
Device Specific	-1.141	-1.595	-1.397	-0.9189	-0.5461	-0.5501
Constant for R/about	-0.933	-1.19	-1.58	-0.77	-0.30	0.95
Speed at	-0.0244	0.0019	-0.0104	0.0013	-0.0355	-0.0188
Device (M,R,T)	-1.80	0.015	-1.20	0.10	-2.33	-2.25
Speed 100m from	-0.0491	-0.0258	-0.0393	-0.0759	-0.0559	-0.0548
Midblock	-2.45	-1.39	-3.14	-3.52	-2.42	-4.00
Speed 100m from	-0.0190	-0.0424	-0.0274	-0.0489	-0.0424	-0.0381
Roundabout	-1.08	-2.16	-2.24	-2.73	-1.76	-2.91
Speed 100m from	-0.0498	-0.0626	-0.0549	-0.0564	-0.0557	-0.0445
Threshold	-2.46	-3.24	-4.19	-3.36	-2.31	-3.59
Council Pays	0.2722	0.0519	0.2614	0.2039	-0.9949	-0.5831
Dummy Variable (M,R,T)	0.49	0.09	0.68	0.38	-2.09	-2.05
Noise Reduction	2.380	1.204	1.85	3.012	1.681	2.085
Dummy Variable (M)	2.90	1.64	3.57	4.00	1.93	4.43
Noise Reduction	1.317	2.789	1.944	2.267	2.007	1.729
Dummy Variable (R)	2.00	3.67	4.10	2.98	2.37	3.5
Noise Reduction	1.779	1.209	1.458	1.499	1.796	1.796
Dummy Variable (T)	2.73	1.56	3.07	2.02	3.67	3.74
Personal Income	-0.0023	0.00045	-0.0011	0.0036	0.0007	0.0020
Effect for M/block	-1.59	0.33	-1.20	2.62	0.522	0.31
Landscape Danger	-0.5729	-1.333	-0.6922	-13.44	-3.365	-2.348
Effect for M/block	-0.88	-1.76	-1.49	-0.01	-2.75	-2.36
Pseudo-r squared	0.29	0.30	0.26	0.35	0.40	0.32

Note: Estimated paarmeters and t-values are given for each attribute in the models

Attribute	Stage I “Before”			Stage II “After”		
	Both Stages	Stage I Only	Full Sample	Old Design	New Design	Full Sample
Speed at Device:						
Mid-Block	-0.163*	-0.370	0.028*	-0.270	0.018*	-0.440
Roundabout	-0.162*	-0.370	0.028*	-0.270	0.018*	-0.450
Threshold	-0.162*	-0.370	0.028*	-0.270	0.018*	-0.439
Speed After Device:						
Mid-Block	-0.353	-0.388	-0.240*	-0.478	-0.588	-0.450
Roundabout	-0.285	-0.200*	-0.379	-0.332	-0.436	-0.326
Threshold	-0.480	-0.433	-0.509	-0.392	-0.493	-0.414
Mean Probabilty of Choice:						
Mid-Block	0.287	0.250	0.333	0.401	0.385	0.421
Roundabout	0.408	0.423	0.389	0.279	0.281	0.276
Threshold	0.305	0.326	0.278	0.320	0.333	0.303
Sample Size	72	92	164	76	96	172
No. of Cases	216	276	492	228	288	516

Notes: Means are given for the elasticities
Items starred (*) are derived using parametr estimates which are not statistically significant.

The emphasis herein is not on spatial transferability of community attitudes and preferences but on temporal transferability. We have, however, recognized the value of a method capable of spatial transferability and thus have excluded any potentially important influences on choice that are too location-specific. The empirical enquiry actually failed to identify any factors of statistical significance that are site-specific, thus opening the opportunity to apply the models in other locations. The final set of attributes that have a strong statistical influence on individual preferences for particular devices have been identified from the testing of a large number of hypotheses. With the exception of personal income, the attributes in the model are all device attributes.

Some important conclusions can be drawn from the comparison of the marginal effects and device-choice elasticities. The evidence suggests that residents with some experience with devices “after” have different preferences to residents with little or no experience with devices “before.” This is particularly borne out by the device-choice elasticities with respect to speed at the device, where we see a much greater sensitivity after the introduction of devices than before. Of particular note is the almost reversed device-choice probabilities for midblocks and roundabouts (with threshold probabilities remaining almost unchanged). We suspect that, in the “before” study, community preferences for roundabouts were greater than for midblocks because there was greater awareness of the speed benefits of a roundabout when compared to an essentially unknown device, the midblock. However, after the implementation of the devices, the speed benefits of midblocks became much more apparent, resulting in greater support for midblocks than there was prior to their introduction. The results for thresholds tend to go in the opposite direction, suggesting that the expectations of speed benefits associated with the introduction of thresholds were not realized.

The respondents in column one, “both stages in the before” study, and the fourth column, “old design in the after” study, were both administered the same choice-attribute levels. Where the marginal effects are statistically significant, we find that the impact of a change in the attribute levels (primarily noise level) changes the probability of device choice significantly more for midblocks and roundabouts after their implementation and significantly less for thresholds. The midblock-specific personal income effect changes sign, being negative in the before situation and positive after the introduction of the devices. For roundabouts and midblocks, most ratings fell over time. For thresholds, all ratings decreased over time, some quite substantially.

This is an important message. It suggests to us that community-preference models, estimated prior to the introduction of devices, are not an appropriate medium for establishing the community's real levels of support for devices. In setting guidelines for community acceptance of devices, we strongly support the application of community-preference models estimated from a sample of residents who have been exposed to the full range of potentially-applicable devices.

In interpreting the device-choice models, it is important to recognize that the models are concerned with the probability that a resident will prefer a particular device, given the available set of devices, as a SATM “solution” to improve levels of speed, noise, and safety. That is, they are conditional choice models. They are not models concerned with whether a resident likes devices *per se* or not (i.e., the choice between having or not having devices). This distinction is very important. What we learn from this study is the likely range of support that the local Council could expect from the community, consequent on a number of alternative devices being introduced. Given the predicted changes in speed along the affected streets, the noise levels, and the income of residents (the latter as a proxy for commitment of views and influence), the model can be used to provide indications of likely differences in community support for alternative schemes.

A number of comments should be provided to appreciate some of the findings that led to the exclusion of potential sources of relative community support and the inclusion of other effects.

1. The location of devices is essentially an engineering decision. We found no significant relationship between preferences for one device or another and the amount of traffic currently on a resident's street.

2. Thresholds gather community support in respect of their cost, especially if the Council has to pay for them; however the financial dimension, when placed in the context of safety and noise considerations, is of less relevance. There is no evidence to support the hypothesis that residents with the devices currently installed in their street or residents who live on streets with a bad accident history (including particularly bad spots) prefer one device over another device.

3. Safety is the overriding concern of residents. This is very much correlated with the speed profile of the traffic in the street and the way that each device can assist in improving this profile. In the “after” study, the midblock has come to the fore as a much more desirable SATM construct than the evidence from the “before” study suggested. This is, we believe, due primarily to a lack of

experience with mid-blocks compared with the more common roundabouts and thresholds. As a result of this newly gained experience, residents now see the midblock as a most desirable device with respect to the way it has slowed down the traffic. It should be recognized that a roundabout, in particular, is situated at an intersection or junction where drivers traditionally exert more caution in the absence of a device; whereas a midblock is situated some distance from an intersection in a location that is traditionally susceptible to relatively higher speeds. Consequently the placement of a midblock is expected to have a significant impact on the change in speed. There is a concern, however, that midblocks are also potentially the most dangerous device from a driver's perspective, in that the design if not very carefully landscaped can be a safety hazard. Compared to roundabouts and thresholds, midblocks require careful thought with respect to landscaping, so as to minimize the risk of injury to vehicle occupants.

Application of the Model

To illustrate the way in which the model can be applied, let us set out the three equations associated with the "full" sample model for the three devices in the "after" situation, that are derived from the device-choice model. Given the levels of the attributes on the right-hand side of each equation, we can identify the relative satisfaction associated with each device.

$$\text{Roundabout} = 0.5501\ \ 0.0188*\text{SPEEDAT}\ \ 0.0381*\text{RSPDFRM}\ \ 0.5831*\text{MRTCNCL} + 1.729*\text{RNSLESS}$$

$$\text{Midblock} = 0.2460\ \ 0.0188*\text{SPEEDAT}\ \ 0.0548*\text{MSPDFRM}\ \ 0.5831*\text{MRTCNCL} + 2.085*\text{MNSLESS} + 0.0020*\text{MPINC}\ \ 2.348*\text{MLDNG}$$

$$\text{Threshold} = 0.0188*\text{SPEEDAT}\ \ 0.0445*\text{TSPDFRM}\ \ 0.5831*\text{MRTCNCL} + 1.796*\text{TNSLESS}$$

Where:

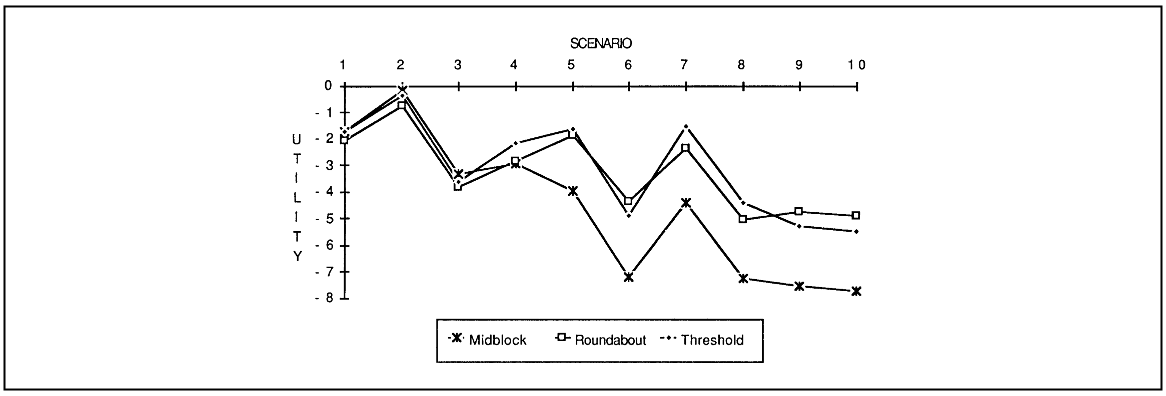
SPEEDAT = speed at the device;
jSPDFRM = speed 100 meters from device *j (j=M, R, T)*;
MRTCNCL = council pays dummy variable (1=Council pays, 0= Other source);
jNSLESS = device provides a reduction-in-noise dummy variable for device *j (j=M, R, T)*;
MPINC = personal income effect specific to mid-block;
MLNDG = midblock-specific landscape-danger effect (dummy variable).

For example the equation for midblock is made up of: its specific constant, the speed at the device attribute, the speed 100 meters from the midblock, the council-pays dummy variable, a noise-reduction dummy variable, a personal-income effect for midblock, and the landscape-danger effect for a midblock.

	All Devices				Mid-Block Only	
Scenario	Speed at (kph)	Speed from (kph)	Council Pays	Noise Reduction	Avg. Inc. ($'000)	Dangerous Landscaping
1	20	30	0	0	35.899	0
2	20	40	0	1	35.899	1
3	20	60	0	0	35.899	0
4	20	80	1	1	35.899	0
5	40	60	0	1	35.899	1
6	40	80	0	0	35.899	1
7	45	55	1	1	35.899	1
8	45	80	0	0	35.899	1
9	60	80	1	0	35.899	0
10	70	80	0	0	35.899	1

The set of equations can be applied using a spreadsheet to identify the relative levels of utility associated with devices, given the particular attribute levels. That is, the levels of the attributes can be altered and the devices themselves changed, with the equations predicting the outcomes. Figure 1 was calculated using a spreadsheet, depicting the relative ratings of different devices with the same attributes as specified in Table 7.

From Figure 1, we can see that the relative ratings differ depending on the device, when all attributes are the same. The midblock has the highest relative utility rating for scenarios 1 to 3, and the lowest for the remaining scenarios. The roundabout and the threshold have relative utility ratings that are similar for every scenario, crossing each other on a number of occasions. Scenario 2 has the highest relative utility rating for each device, with scenario 10 receiving the lowest rating. However, engineering



constraints will usually decide the most appropriate type of device for a particular situation, while a spreadsheet can provide an insight into the best combination of attributes for the chosen device.

Different schemes can also be evaluated with respect to mixes of devices and predicted attribute levels, automated by a spreadsheet application. The planning agency can identify which scheme is likely to provide the highest level of community support as measured by its ability to generate the maximum level of expected satisfaction (EMS) from the evaluated set of schemes.

An example of a scheme with one of each device would be:

$$\mathrm{EMS} = \ln[\exp(M) + \exp(R) + \exp(T)]$$

A scheme involving only a midblock and a roundabout would be:

$$\mathrm{EMS} = \ln[\exp(M) + \exp(R)]$$

A scheme involving two roundabouts and one midblock would be:

$$\mathrm{EMS} = \ln[\exp(R) + \exp(R) + \exp(M)]$$

CONCLUSIONS

It is important to involve potentially-affected communities in any traffic plan to resolve public-issue responsibility. The choice-modelling approach provides an appealing framework within which to address public-policy issues that impact on local communities. A combination of discrete-choice models and stated-preference data, at an individual resident level, provides a method to identify which traffic-management decisions will accord with the greater desires of the community. The approach outlined above is relatively simple to implement and provides intuitive outputs to assist in making effective decisions.

Overall the study found that the sample of residents approve of the scheme. They believe that, since the introduction of SATM, the speed of the traffic in the area has decreased, and safety has increased as a result. Therefore, the scheme has been successful in the area. However, a majority of respondents expressed a concern about the volume of traffic in the area. Perhaps this is due to an expectation that the scheme would reduce the volume of traffic in the area. Traffic counts in the area, however, have shown that the volume in the area has actually decreased. We believe that this is because SATM schemes were unknown to the community until they were installed in this area. The residents are familiar with local area traffic-management schemes (LATM) that divert the traffic. Therefore, although SATM is not designed to divert traffic away from the area, the residents may have expected this due to their experience with other traffic-management schemes. This finding is an important one for planners. In future there should be more community education about the effects of SATM schemes, and especially in comparison with LATM schemes.

The before and after approach has shown that the results from the “before” survey were not totally indicative of the results obtained in the “after” survey. This is due to the lack of experience of the residents with the scheme and its devices. When setting guidelines for community acceptance of devices, we strongly suggest that they are based on a sample of residents who have been exposed to the devices under consideration. However, this should be combined with a community-education program before the installation of the devices, and/or an attitudinal survey. Local residents must be involved in the decision-making process if maximum acceptance of a scheme is to be achieved. There should be opportunities for the community to provide input to the planning process, and the community should be kept informed of any proposed developments.

The results, while not transferable over time, may be transferable between locations. We recommend that a follow-up study should be carried out in a different location to assess the attitudes and preferences of another sample population in comparison to those of the current study. The discrete-choice model used in the study used attributes that were not specific to a location so that this hypothesis can be tested. The model can be used with a spreadsheet to predict the preferences for devices and combinations of devices. This technique is an important tool for planners.

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