Methodology for Assessing Transportation Policy Impacts

Peter M. Jones, Transport Studies Unit, Oxford University

Travel-demand models may make a variety of assumptions about the way in which people respond to transportation policies. It is important to choose an appropriately specified model for a particular impact study. Full impacts cannot always be anticipated, however, or they may be too complex to be handled by a mathematical model. This paper describes a survey technique, the household activity-travel simulator (HATS), that is able to examine both the direct and secondary effects of policies on different types of household. The methodology uses display equipment in a household in-depth interview in a way that makes explicit the role of travel in daily life and the constraints and options that influence behavior; household members use the equipment to simulate their responses to policy proposals. HATS thus provides a guide to model selection and development and, where no appropriate model exists, may itself be used as a crude predictor. Several studies have now been completed and it seems possible to relate response patterns to three factors: (a) severity of the policy change, (b) whether the change is forced or permissive, and (c) the types of households affected. Case study findings are presented. The technique provides a useful indication of public opinion and appears more intelligible to both the public and politicians than does a more conventional methodology. The insights obtained from HATS studies also appear to be of wider value to policymakers, since they can help to identify problems clearly, generate a range of policy solutions, and encourage a comprehensive evaluation of the options. HATS also has a more academic role as a research and educational tool.

Transportation planners have a range of disaggregate and aggregate models to use in the assessment of the impacts of various transportation policies. Experience suggests, however, that correct prediction of people's responses to a policy is not always possible, even in very general terms. The third (lunchtime) rush hour on the newly opened downtown sections of the Washington, D.C., Metro subway apparently came as a complete surprise to officials (1). Many British planners were equally unprepared for the secondary effects of traffic restraint in city centers (2).

The unanticipated effects of transportation policies are cited as evidence of the failure of transportation modeling techniques. However, this is often incorrect—the disparity between prediction and outcome may be a symptom of the misapplication of the model, beyond the range of the validity of its assumptions, rather than a basic fault in the model itself. All models make simplifying assumptions about human behavior—by the way they characterize the decision process (i.e., model structure), by the selection of a small set of independent variables to explain behavior, and by the limitations on the range of possible behavioral adjustments (via the model outputs). The important point is to ensure that the representation of behavior embodied in the model is appropriate to the application. This requires that the modeler understand the response pattern that a policy is likely to evoke.

A recent paper (3) has proposed a tentative fourfold classification of response patterns, based on the degree of interaction (or strength of linkage) between individual travel decisions. These model domains assume

1. Independence between successive travel decisions made by one individual and between decisions made by different people (except at an aggregate level where congestion levels, for example, may be affected);
2. Spatiotemporal linkages where the individual is also an independent decision maker, but his or her travel decisions are interdependent in space and time (e.g., shopping travel linked to the work trip);
3. Interpersonal linkages where a travel decision is taken jointly by members of a group (e.g., the household), or where decisions taken by one person will directly affect the behavior of others; and
4. Full interdependence where strong interpersonal and spatiotemporal linkages operate.

A second level of complexity is introduced by the nature of the policy and the degree of compulsion involved. We may distinguish between policies that lead to forced and permissive responses (3). The former might involve the withdrawal of a bus service or change in school hours and the latter might involve the introduction of an additional facility (e.g., new shopping center or road improvement). Impacts of permissive policies are more difficult to anticipate because of uncertainty about who will hear of or take advantage of the change.

In the physical and applied sciences, empirical relationships are recognized to apply within defined limits (e.g., certain ranges of temperature or pressure), but a similar notion is not prevalent in the social sciences. Most operational travel-demand models make domain 1 assumptions about behavior, but the outcomes observed in Washington and the United Kingdom represent responses to policy that lie outside of this domain. Transportation researchers are not yet able to define domains precisely nor to provide models that operate satisfactorily in the more complex domains (although disaggregate modelers are beginning to consider a wider range of linkages).

This paper describes a survey technique that may be used to explore likely responses to a policy and, by identifying the relevant response domains, to provide a means for selection of an appropriate travel-demand model. In cases where the policy appears to have major direct and secondary effects that cannot be handled by available models, the technique itself may be used as a crude predictor by using a larger sample of respondents. Insights gained from applying the technique can aid policy generation and evaluation and provide a basis for the development of formal models that are designed to operate in the more complex domains.

STUDY METHODOLOGY

The full range of potential responses to policy measures (both direct and secondary impacts) can be accommodated by working at the domain 4 level. In this way we can establish whether certain linkages remain undisturbed by a proposed change and hence the extent to which impact assessment can confidently proceed, by using techniques that assume simplified response patterns.

Domain 4 level linkages can be studied by viewing travel behavior as part of a daily pattern of human activities—the things people do in time and space (4). Instead of being represented as discrete, independent entities, trips are viewed as part of a continuous pattern of events in time and space. Trip making is but

one of many daily activities, but it has the special characteristic that it represents the means by which people move through space in order to use facilities for activity participation at different locations. Figure 1 contrasts the traditional conception of travel embodied in domain 1 models with that implied by the human-activity framework. A review of the literature and discussion of some of the implications of the approach for travel-demand modeling may be found in another article (5).

By using this theoretical approach, the Transport Studies Unit has developed a survey technique, the household activity-travel simulator (HATS), to examine the daily structure of household activity and travel patterns and to explore the ways in which people respond to policy changes.

The HATS Interview

HATS is composed of a set of display equipment that is used by household members in a carefully designed group in-depth interview. The survey procedure used in HATS policy studies is shown in Figure 2. Prior to the main interview, sampled households are asked to provide basic sociodemographic information and to keep a record of behavior, which indicates the timing and location of each activity, for a specified number of days.

At the beginning of the main interview each participant constructs a physical representation of a selected diary day on a display board, by using colored blocks and markers to represent an activity pattern. A completed HATS display board is shown in Figure 3. The lower part is used to represent the temporal pattern of the person's day. Appropriately placed colored blocks indicate how time is spent on different activities throughout the day and whether this is at home, away from home, or in traveling. The upper part of the board uses a map or some other spatial representation to indicate where the activities took place and to record the travel modes and routes that link them. In most studies between 10 and 12 activity groups are distinguished by color. A comparison of Figures 1 and 3 demonstrates how the theoretical framework is clearly translated into the HATS board representation.

Once this exercise has been completed the interviewer asks respondents to describe and account for existing behavior patterns, and in this way the group identifies existing interpersonal linkages, spatiotemporal constraints, and activity opportunities.

The interviewer next introduces the proposed policy change (e.g., revised work hours or changes in transit service) and asks the group to consider how it might affect their existing behavior. Where respondents consider making adjustments or rearrangements to their day, they test them on their boards to see if they are feasible (see Figure 4). The HATS representation imposes a number of logical checks on the spatio-temporal feasibility of suggested responses and helps to make explicit the interpersonal linkages that may be affected (e.g., chauffeuring arrangements or meal-times).

As an example of the way these checks operate, consider the reaction of households to an improved transit service. Many people appear to be in favor of the system at the time of survey but fail to use it once implemented. The technique largely removes this effect by imposing a series of built-in checks on responses (through the boards and group discussion):

1. Is the system accessible to the respondent and does it serve destinations that he or she would wish to visit? Are activities there that the respondent would wish to pursue?
2. Does the service run at times when the respondent would be able, or would wish, to use it for both outward and return journeys?
3. Is the respondent prepared, or able, to commit a sufficient block of time to allow for the return journey and the time spent at the destination?
4. If use of the service involves extra travel, or a change in activity or destination, what will the respondent give up in its place (since more time on one activity can only be at the expense of another)? and
5. Are linkages with other people affected? How do they react? What indirect problems might it cause?

By using an in-depth interview format, it is also possible to probe other factors that are not directly shown

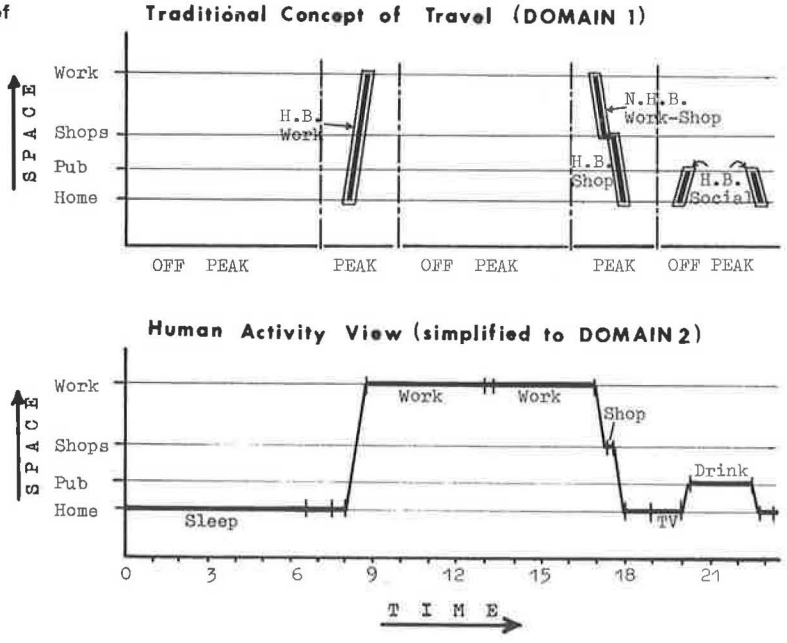


Figure 1. Alternative representations of travel in different domains.

Figure 2. HATS survey procedure.

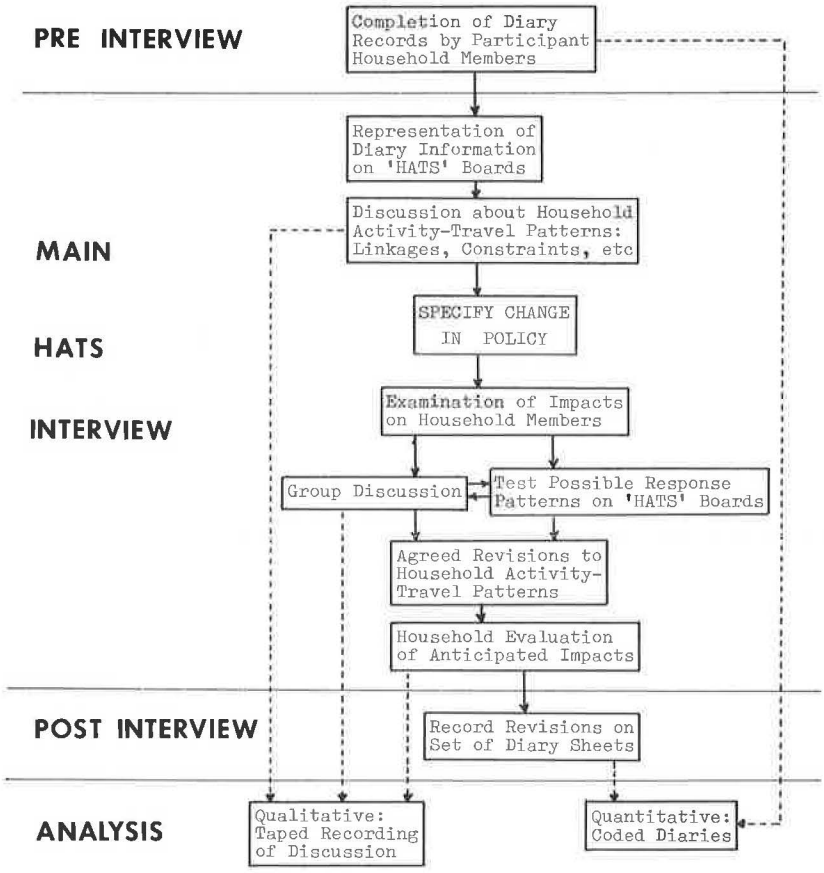


Figure 3. A completed HATS display board.

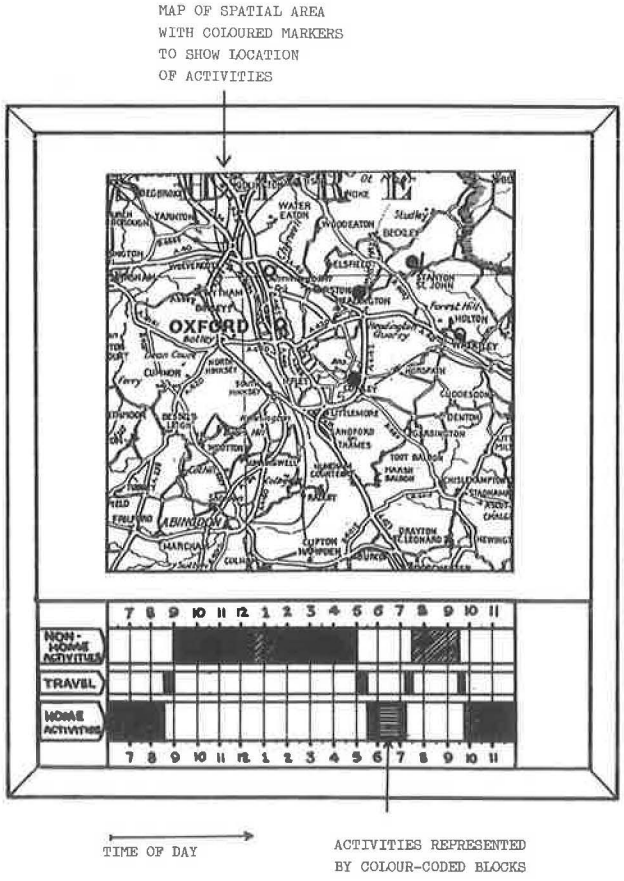
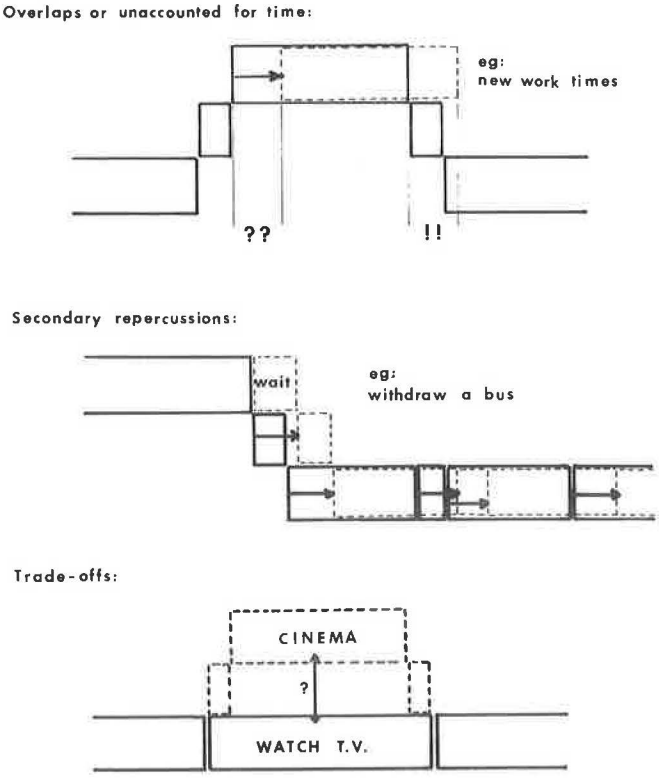


Figure 4. Examples of checks built into the HATS interview.



on the boards, such as comfort, safety, and cost and to get the reactions of other household members as to the realism of the responses of each member.

Once household members have agreed on likely revisions to their activity-travel patterns they are asked to give their opinions as to whether they regard the impacts as beneficial or adverse and in what way. This concludes the main interview, which normally takes from 1 to 1.5 h. The interviewer subsequently notes any revisions that were made to the boards on a second set of diary sheets. A more detailed description of the HATS interview procedure may be found elsewhere (6).

Data Analysis

The interviews produce a tape recording of discussion and comment and diary records of current behavior and HATS-simulated modifications.

Tape analysis usually begins with the preparation of formal transcripts from a sample of interviews. These are subject to a detailed content analysis to select themes around which reports of each interview can be prepared. This is preferable to the specification of a report structure a priori, since part of the value of a HATS study is to reveal the unexpected. Each report contains a mixture of notes and quotations, which may be supplemented by tables and diagrams. Where possible the report is prepared directly following the interview, so that any unexpected points that do emerge can be probed more fully in subsequent interviews.

The diary records perform three functions during analysis:

1. Quantitative descriptions of the behavior patterns that are discussed in the tape reports,
2. Data base for examining hypotheses and relationships that result from the tape analysis (this may be supplemented with data from a local transportation study), and
3. A measure of the quantitative impact of a policy change, in conjunction with simulated after records of behavior.

A detailed description of the analysis of HATS diaries is given in Clarke (7).

The relative importance of the diary and tape data depends on the nature of the policy change that is being considered. For forced changes, the paired diary records are usually the main source of data, and the tapes provide additional insight in the form of qualification, understanding, and evaluation. For permissive policy changes, however, many households do not modify their boards during the interview and the primary emphasis rests on the tape output and on obtaining an indication of the relevance of the proposed changes to existing household activity patterns. Here the diary data are used to examine insights (formulated as hypotheses) that emerge from the tape analysis.

APPLICATIONS

HATS was conceived early in 1975 as an adaptable means for examining existing household behavior and exploring response to change. It has undergone two field trials, which involved before-and-after studies into the effects of school-hour changes (8) and the impacts of reductions in frequency of rural buses (9). The latter was based on an independent assessment of the technique by consultants, who reported favorably on its use and potential. Although sample sizes in both studies were small, HATS appears to give realistic indications of probable policy impacts and works particularly well in larger households, which are composed of parents and children. Such groups have complex interpersonal linkages that currently are not clearly understood and their members are directly or indirectly affected by a wide range of policy proposals.

HATS is developing into a useful and sophisticated social survey technique and is being used or considered by several British local authorities as a means of assessing transportation policy impacts. Two studies currently under way are using HATS to investigate the likely effects of improved transit services (both bus and rail) and projects now being discussed include policies to change work or school hours, the impact of a new mass transit system, and the optimum scheduling of low-frequency bus services. The technique not only provides general insights into policy impacts; it also makes clear the particular advantages and disadvantages of proposals (such as improved transit) for potential users. This information can be used in the design of publicity material.

In one application, a county council is using the technique to validate or adjust the behavioral assumptions of its conventional four-stage travel-demand model. The model is being used to examine the effects of a policy to upgrade a local commuter rail service (more stations, greater frequency, and feeder buses). They are concerned that their model is unable to allow for certain perceived attributes of the service (e.g., comfort or reliability) or to incorporate possible secondary effects, such as the reallocation of the household automobile.

Where possible, local staff are trained to conduct a proportion of the HATS interviews themselves, so that local authorities can have the full benefit of the knowledge gained—not all of which is in a form that could be incorporated into a study report. Interview and analysis manuals are prepared for each application, but the unstructured nature of most studies requires a series of skilled training sessions. An educational version of HATS enables interviewers to take on the role of household members responding to a particular policy change. This is proving to be a useful training aid.

Understanding Response Patterns

The studies completed to date have provided valuable insights into the ways in which people respond to policy changes (both hypothetical and real) and the nature and extent of any linkage effects. Response to a policy seems to relate to three factors:

1. The severity of the policy change,
2. Whether change is forced or permissive, and
3. The types of household affected.

The more severe a policy change, the more likely it is to have a significant impact on households. This is intuitively obvious, but the HATS technique provides a means of quantifying reaction to specific policies and makes clear the mechanisms that are involved. Other things being equal, the more a policy affects the location or timing (or cost) of activity or travel facilities, the less likely it is that the overall activity pattern will remain unchanged and the more likely that nonusers will be indirectly affected. In some respects an activity pattern is analogous to a kaleidoscope. A small policy change usually has only a minor impact (taking up some slack in a person's day or reducing the pressure they find themselves under), but as the change increases in magnitude a point may be reached where a fundamentally different pattern is formed.

The distinction between forced and permissive change

lies not so much in the nature of the response pattern but in the certainty of the reaction. The group affected by a forced change can usually be readily identified; it can be assumed that they have perfect knowledge of the change and that they will adjust to the new situation in some way. By their nature, permissive changes tend to increase choice and invite, rather than demand, a response. As a result, identification of the groups who might benefit is more difficult, and it is hard to be sure of the extent to which individuals will become aware of the change. When the magnitude of a policy change is small, forced changes are usually more effective at modifying behavior than are permissive ones. Increased parking difficulty is more likely to change the mode or destination of trips than will a transit improvement. When the improvement is perceived to be substantial, however, a permissive change may lead to as radical a response as a forced one. The opening of a new shopping center, for example, may affect the destination, mode, timing, frequency, and travel group for household shopping trips and so significantly change daily activity patterns.

Household and personal characteristics are a third important factor that affects reaction to a policy. They determine whether a policy is relevant to a person, how much scope for marginal adjustment they have, and whether other people are likely to become involved. Retired people, for example, have less tightly constrained activity patterns and so are usually able to absorb changes by taking up slack and, because they are home-centered, spatiotemporal linkage effects are usually few. Conversely, children are closely tied to their parents and the clock, and the whole family is usually involved in any policy that affects them. As the children grow up they become more independent until, once they have their own automobile, they have few daily links with other household members and respond to many policies as though they were embryonic one-person households. Thus, it may be necessary in some cases to disaggregate policy effects by household type and use differently structured models that reflect the different response patterns of each group.

Case Studies

An example of the effect of a forced change is provided by a study of school-hour changes, which was performed in West Oxfordshire. In this instance the policy varied in its consequences for different families because it involved both a 0.5-h change in school hours and a revised pattern of statutory school transport. As a result, children left or arrived home as much as an hour earlier. This provided the opportunity to examine the importance of the magnitude of a change in timing.

The study found that a small adjustment in timing in the morning could disrupt established household routines and cause some resentment. There appeared to be more slack in the afternoon, but when children arrived home at least 0.5 h earlier, fundamental changes in activity patterns occurred. The extra time between arrival home and the evening meal enabled the generation of late afternoon trips (for shopping or personal business activities) or their transfer from nonschool days. Alternatively, children now had enough time to complete homework before the evening meal and to leave the evening free for a range of outside activities (hence leading to increased trip rates). In families where children traveled to school by automobile (instead of by school bus) interpersonal linkages were more likely to be affected by the timing changes. Further findings and a full account of the study are available elsewhere (6, 8).

Transit improvements are a good example of a permissive change and two studies are currently examining the effect of such changes on household activity patterns. The first is being conducted in Basildon new town, Essex. As part of a general improvement in bus services in the town, the service headway from one new residential development to the town center was decreased from 2 h to 0.5 h. This was chosen for a before, HATS, and after study. A half-hourly rail service to the town center was available from a station 1-1.5 km away in a valley and was both faster and cheaper than bus service. The authority was interested in how the improved service would be received, whether it would attract former rail users (because of its greater door-to-door convenience), how useful it would be for intermediate journeys not served by rail, and whether a substantial number of new trips would be generated.

HATS interviews suggested that local residents would welcome the service but that few trips would be generated. A few would switch from rail to bus, but the main effect would be a shift from walking to bus for trips in the 1-2 km range. Activity patterns would not be significantly affected by the service improvement and there would be no major linkage effects; a standard mode-choice model, which included walking trips, would capture the main impact. Preliminary analysis of the after survey data supports this conclusion.

The second study was conducted in the suburbs of a larger urban area (10), where many local facilities were not within walking distance and intersuburban bus services were poor. Husbands in one-automobile households commonly used the automobile for the journey to work, which caused considerable accessibility and scheduling problems for wives, especially if they had young children. Given an improved transit service to work, husbands seemed willing to relinquish their use of the automobile so that the spouse could use it for shopping, child-chauffeuring activities, or commuting to a part-time job. In some situations, therefore, an improvement in transit service may invoke both interpersonal and spatiotemporal linkage effects and thus enable the adoption of a more complex or less tense daily household routine.

MODELING IMPLICATIONS

Most operational travel-demand models implicitly operate within domain 1 (see Figure 1); that is, they treat trips as separate entities and predict a person's demand for travel without reference to their other trips or to other decision makers. In some instances this may be a reasonable simplification, as when the policy change is small or the affected individuals have very simple travel patterns, but on other occasions this is an oversimplification.

The HATS studies demonstrate how, under certain conditions, linkages between events and people are brought into play and significantly modify the simple response pattern that would result from domain 1 assumptions. Take, for example, an individual's choice of travel mode. Standard domain 1 models account for mode choice as the outcome of trade-offs between the attributes of competing modes for the trip in question. From findings to date, a rational choice may take account of a wider set of interrelationships:

1. Characteristics of the trips to and from the destination (such as mode choice for the journey to work, depending in part on the alternatives available for the journey home),
2. Characteristics of more complex trip sequences on one excursion away from the home base (thus an auto-

mobile may be chosen for the journey to work because of the need to use it for business or to run errands during the lunch hour), and

3. Interdependencies between household members (a husband may forego use of the family automobile for his journey to work so that the wife can use it to chauffeur the children during the day).

If a model is used that assumes the independence of trips when in fact significant linkages operate, the resulting misspecification may lead to incomplete and biased forecasts of policy impacts.

It seems intuitively likely that, the more linkages a model incorporates, the more complex will be its structure and the more expensive it will be to operate. Traditional domain 1 models will thus continue to have an important role to play in cases where their assumptions are appropriate. In other instances, however, there is an urgent need for operational models at the higher-order (domain 2-4) levels (3). There are as yet no models that fully incorporate domain 4 linkages. However, when policies are considered that invoke such linkages, HATS may be used as a crude predictive device, by using a larger sample of households.

A limited validation of the predictions from a HATS study was carried out as part of an assessment of the technique for the United Kingdom Transport and Road Research Laboratory (9). The study examined the effects on 22 rural households that use buses of a severe reduction in off-peak service frequency (from 8 buses/day to 2 buses/week). Table 1 (9) summarizes trips made before the change, those predicted in the HATS study, and trips reported in an after study. When allowance is made for seasonal variations, the results are encouraging; a much larger validation exercise is planned for 1979-1980.

Used predictively, HATS seems to offer one advantage over a conventional model: It makes clear the degree of uncertainty in forecasting. In some applications (particularly those that relate to permissive changes) it is not always possible to arrive at a single most likely household response pattern but rather a range of responses (e.g., which reflect different levels of anticipated service reliability). A conventional modeler might interpret this as a failing of the technique, because it gives uncertain answers, but it probably reflects a real variability in response.

ASSESSMENT

The HATS technique seems to be particularly relevant to the assessment of the effects of transportation policy. It is able to examine both the likely direct and secondary repercussions of a policy and to provide a guide as to the public acceptability of the proposals. Experience in the United Kingdom also suggests that the study methodology and findings are readily assimilated by local politicians, who find it more intelligible than conventional assessment procedures.

By its nature, HATS is primarily an exploratory device, to be used when policy impacts are uncertain or as an aid to policy generation. HATS might be a cheaper technique to use for forecasting than a conventional model in a small local study, but it would normally only be sensible to use it as a formal predictive device on a larger scale when strong linkage effects were anticipated that could not be handled by an existing operational model. Costs of using the technique depend on the type of application (in particular the importance of the very skilled, in-depth component of the interview and analysis), but have been estimated at between 5 and 15 times that of a standard home-interview survey, which collects only one-day travel diary and demographic information (9); the higher cost is comparable with that of a typical group, in-depth interview. The HATS interviews provide a much wider range of qualitative and quantitative information than do conventional studies, and the higher costs are offset by the use of much smaller sample sizes. Any direct comparison is invalid, however, since the two procedures have very different objectives.

Although this paper has emphasized the role of HATS in impact studies, the technique is very flexible and adaptable and has a wide range of potential policy applications—particularly if used in conjunction with other survey or analysis techniques. In the Basildon study, for example, the study team found that the insights from the HATS interviews helped considerably in the subsequent design of a transit attitude and use survey in the town. In other instances, authorities have used the findings in a transit-marketing exercise. Where possible, a conscious effort is made to link HATS findings with outputs from traditional planning and travel surveys.

In a research context, the technique has obvious value as an aid to theory and model development, and is particularly useful at eliciting the decision rules that should be built into behavioral models. The notion of constrained trade-offs is basic to the HATS interview procedure (i.e., more time on one activity is gained at the expense of less time on another), and this opens up possibilities for developing more realistic evaluation procedures. Finally, HATS has been proven to be useful as an educational aid, both as a means of illustrating the role of travel in daily life and in a more sophisticated way as a gaming device, where students take on the role of household members and simulate the impact of alternative policies on the household's daily routine.

Table 1. Change in travel behavior caused by a village bus service reduction.

Travel Mode	Total Trips per Day[a]		
	Behavior Before	HATS Response	Behavior After
Village bus	29	9	8
Walk and other bus	5	9	9
Bicycle and other bus	0	2	1
Automobile passenger and bus	0	1	0
Automobile passenger	14	10	12
Automobile driver	4	4	12[b]
Bicycle	0	2	2
Walk	34	31	37[b]

[a] Based on 22 interviews.
[b] Increases due to unusual trips on sampled after days plus seasonal effects.

POLICY IMPLICATIONS

HATS findings also have more general implications for the evaluation and formulation of transportation policies. Individuals often evaluate transportation policies in terms of their indirect effects on activities, rather than on the travel rearrangements per se, which may include changes to in-home activities (6, 11). The recording procedure used in HATS interviews provides a means of quantifying change in these terms, but there does not always seem to be a simple relationship between degree of change (as measured in time budget terms) and strength of feeling for or against a proposal. This needs further investigation.

The approach also brings out much more clearly

the links between transportation and land-use policies—since every travel change affects the timing or location of activities and hence has indirect effects on the usage of facilities and, in the longer term, on the land-use patterns themselves. Some interviews have also demonstrated one mechanism by which longer-term mobility decisions are triggered. If people are physically unable to adapt to a policy change, given their role requirements and the space and time constraints of their daily activity pattern (or find it very difficult or stressful), they start to consider more basic decisions, such as a change in automobile ownership or a new workplace or residential location. A similar process often occurs naturally in a person's life as circumstances change (e.g., need for a second household automobile or need for a larger dwelling unit as children grow older).

SUMMARY AND CONCLUSION

HATS is a new social survey technique that enables the analyst to examine the role of travel in daily life and the ways in which households respond to change. This knowledge may be used by policymakers to anticipate the impacts of their policies or by the researcher as a basis for the development of theory or more behavioral models. The technique is particularly suited to the identification of the spatiotemporal and interpersonal effects of change and, where complex responses are anticipated, HATS may be used as a crude predictive device.

The incorporation of in-home activities is a key element in the HATS procedure. They have direct relevance to travel decisions (e.g., need to be home by a certain time for a family meal or inability to go out because of young children) and their inclusion completes the picture of daily behavior, and thus enables the systematic examination of secondary policy repercussions. Collecting information on daily activity patterns also seems to result in higher recorded trip rates (7). As more policies are proposed that invoke complex or unanticipated responses, the grounds are stronger for including in-home activities in the impact assessment.

The understanding obtained from HATS interviews also has wider policy value and may provide guidance as to the nature of the problem, the policy options to be considered, and the ways in which their impact might be evaluated. In the longer term the concepts embodied in HATS (even if not the technique itself) are likely to have a strong influence on transportation planning in both the United Kingdom and the United States.

ACKNOWLEDGMENT

The work reported here was largely funded by the U.K. Social Science Research Council. Contributions to this research have also been made by Ian Heggie, Martin Dix, and Mike Clarke. The HATS equipment is covered by a United Kingdom manufacturing patent held by the National Research Development Corporation.

REFERENCES

1. News Section. Transportation, Vol. 7, No. 2, 1978, pp. 247-248.
2. I. G. Heggie. Consumer Response to Public Transport Improvements and Car Restraint: Some Practical Findings. Policy and Politics, Vol. 5, No. 4, 1977, pp. 47-69.
3. I. G. Heggie and P. M. Jones. Defining Domains for Models of Travel Demand. Transportation, Vol. 7, No. 2, 1978, pp. 119-135.
4. F. S. Chapin, Jr. Human Activity Patterns in the City: Things People Do in Time and Space. Wiley, New York, 1974.
5. P. M. Jones. New Approaches to Understanding Travel Behaviour: The Human Activity Approach. In Behavioural Travel Modelling (D. A. Hensher and P. R. Stopher, eds.), Croom Helm, London, 1979.
6. P. M. Jones. HATS: A Technique for Investigating Household Decisions. Environment and Planning A, Vol. 11, No. 1, 1979, pp. 59-70.
7. M. I. Clarke. Towards a Mathematical Formulation of Travel Behaviour Based on Activity Patterns. Transport Studies Unit, Oxford Univ., Working Paper 39, 1978.
8. P. M. Jones. School Hour Revisions in West Oxfordshire—An Exploratory Study Using HATS. Transport Studies Unit, Oxford Univ., Technical Rept. No. 1, 1978.
9. Martin and Voorhees Associates. Reductions in Rural Bus Services—An Independent Assessment of the HATS Technique. Transport Studies Unit, Oxford Univ., Technical Rept. No. 2, 1978.
10. P. M. Jones and M. C. Dix. Household Travel in the Woodley-Earley Area: Report of a Pilot Survey Using HATS. Transport Studies Unit, Oxford Univ., Technical Rept. No. 4, 1978.
11. A. Tannir and D. Hartgen. Who Favors Work Schedule Changes and Why. New York State Department of Transportation, Albany, Planning Res. Rept. 125, Aug. 1977.

Publication of this paper sponsored by Committee on Traveler Behavior and Values.