WORKING PAPER
ITS-WP-00-10

Assessing Data and Modeling Needs for Urban Transport Sector: An Australian Perspective

By

David A. Hensher

March, 2000

ISSN 1440-3501

Established and supported under the Australian Research Council's Key Centre Program.

INSTITUTE OF TRANSPORT STUDIES
The Australian Key Centre
in Transport Management

The University of Sydney
and Monash University

NUMBER: Working Paper ITS-WP-00-10

TITLE: Assessing Data and Modeling Needs for Urban Transport Sector: An Australian Perspective

ABSTRACT: Managing the transport assets of an urban economy and ensuring that change is in accordance with suitable performance measures requires continuing improvement in analytical power and empirical information. One crucial input in an ongoing review of data and modeling capability for improving planning and policy support in the urban transport sector is a recognition of the role of stakeholders and the impact they can have in supporting the ongoing commitment to implementing a state of practice data and modeling strategy. This paper presents a multi-stage stakeholder assessment of data and modeling needs (primarily in the urban passenger context) in Australia that is required to ensure the continuity of appropriate deliverables to a market of diverse stakeholders. The implementation of the framework of inquiry enables data and modeling agencies to remain current and relevant. Such an exercise should be encouraged from time to time as part of good practice.

AUTHORS: David A. Hensher,

CONTACT: Institute of Transport Studies (Sydney & Monash)
The Australian Key Centre in Transport Management
C37, The University of Sydney NSW 2006
Australia

Telephone: +61 2 9351 0071
Facsimile: +61 2 9351 0088
E-mail: itsinfo@its.usyd.edu.au
Internet: http://www.its.usyd.edu.au

DATE: March, 2000

Acknowledgment. *This paper is derived from a larger inquiry undertaken by the Institute of Transport Studies funded by the NSW Department of Transport. The contributions of Tim Raimond, Helen Battellino, Frank Milthorpe and Marcus Wigan as well as the large number of stakeholders and international experts are recognised and appreciated. Detailed comments of two referees and David Greene have materially improved the paper.*

Background

An important task in the development of a Strategic Travel Information and Model System (STIMS) is to establish efficient and effective linkages between the needs of stakeholders and STIMS so as to service these needs. The details of the specific analytical tools is secondary to this objective, representing the translation of needs into behaviourally relevant models and supporting data. For example, a need may be as simple as data on the number of passenger vehicles (by vehicle type) using tolled motorways in an urban area. This is a descriptive statement of actual vehicle flows - a data need that requires appropriate statistical presentation and supporting documentation on the data. Another need may be of a more generic type such as an interest in local air pollution and the requirement to be able to identify what policy instruments (transport and non-transport related) will have the greatest impact on reducing local air pollution. This may be delivered in a number of ways including the application of STIMS to produce suitable outputs; alternatively it may require the simple provision of data to a stakeholder/consultant using the consultants own analytical model system.

These examples highlight a main challenge for a strategic travel information and model system - it must be sufficiently flexible in its architecture to satisfy a diverse set of needs ranging from the provision of basic descriptive data (e.g. trip tables) to outputs from a detailed travel forecasting model system. One useful starting point for the process of development of a data and modeling capability is the design of a consultative process. At least four groups of players should be involved in this process: the stakeholders, the advisers to the stakeholders (e.g. consultants), and the body of analytical and application expertise. The contribution of these players can be captured by a consultative context as summarised schematically in Figure 1. The stakeholders, the wider client base, the analytical experts and the application experts all bring to the design process necessary perspectives on the state of knowledge and its relevance at various layers of decision making.

Each set of consultative instruments has a very specific objective:

- *Stakeholder Interviews:* To identify the policy-based obligations of an organisation and the role that travel and transport information does play and might contribute in the future to the planning and decision-making process.

- *Client Workshops:* To enrich the perspectives of stakeholders and the ‘expert’ set, identifying, through debate and discussion, the broader set of information needs of stakeholders and other clients in the chain of participation in transport planning and decision-making and the most effective way of delivering the products.

- *Analytical and Application Experts Activity:* To identity the state of the art and the state of practice in areas of information associated with travel models and travel data; and to establish the important linkages between the state of play and its relevance to the transport planning and decision-making process.

An important distinction is drawn between analytical and application experts. The latter have often ‘evolved’ from the former, moving away from basic and non-policy directed applied research towards policy-directed research-oriented applications. In some instances the application expert is a manager of a team (residing in a government

agency, a University or a consultant firm), directing their activities, yet they have a wealth of knowledge of the appropriateness of analytical and data tools in servicing the needs of a client base. By contrast, the set of analytical experts includes researchers whose primary goal has been the advancement of the state of knowledge with limited commitment to particular applications, at least in the first instance. The analytical experts however are well positioned to identify the subsequent contributions of particular pure research activities that define the state of the art in future development of the state of practice. A good example is the research in the 1970's in discrete choice models of the logit and nested logit forms (eg McFadden 1981, Hensher and Greene 1999) which became state of practice application tools in the 1980's. Stated preference and stated choice research in the 1980's is now seen in the state of practice in the 1990's (Louviere, Hensher and Swait 2000), as is the embedding of all spatial data in a Geographic Information System (Dueker and Ton 2000).

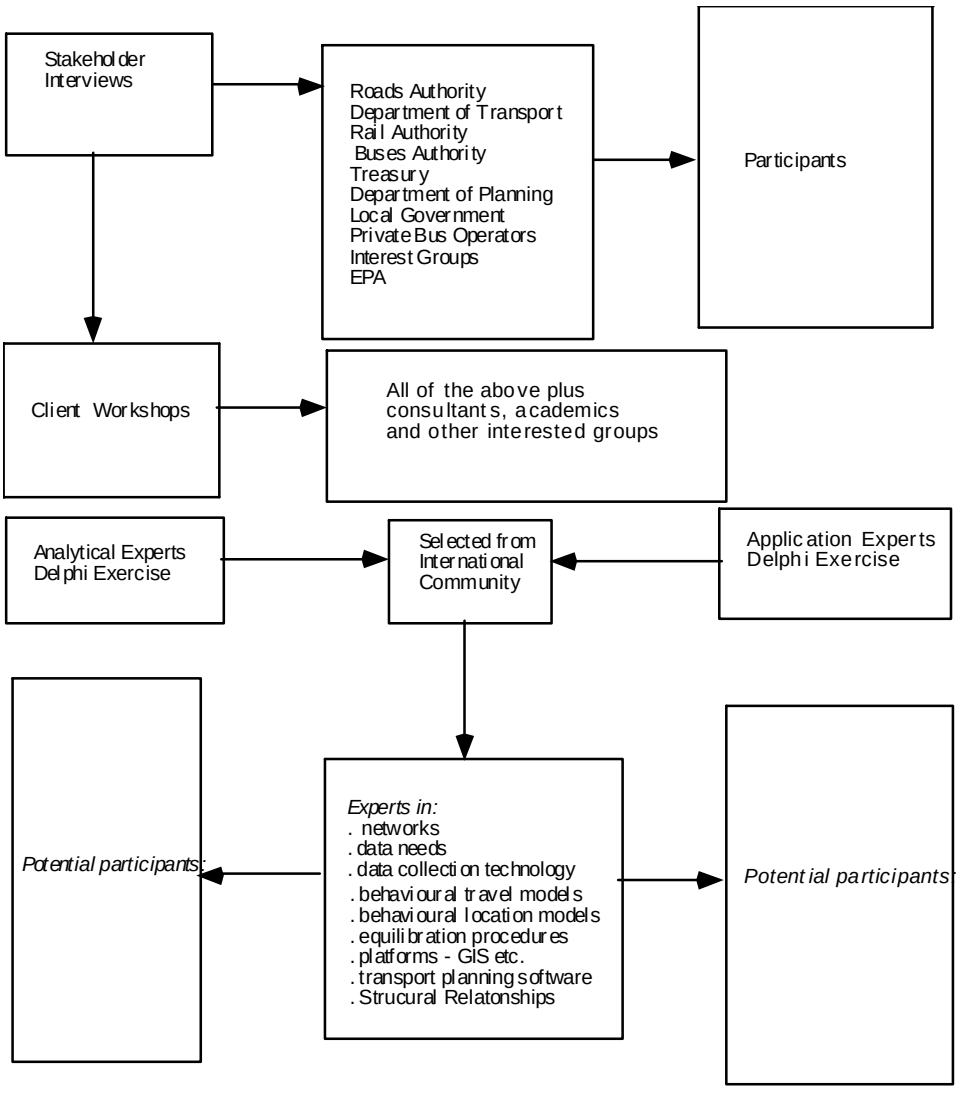

Figure 1 The Consultative Context

This paper presents the process designed and implemented in the review of the information and modeling capability of the NSW government in the mid-nineties as part of a broader study to design a new strategic urban travel information and model system

for Sydney. This was in response to a concern by stakeholders that the existing strategic travel passenger model and associated data were reflective of the interest in justifying new road capacity and little else. This 'relic' of the 1970's was well overdue for a major review and replacement to recognise the broadening base of transport policy. The consultative process provides useful benchmarks for inquiries in other geographical settings.

The Stakeholder Interviews

Background

A face to face interview was undertaken with twelve key stakeholders in NSW, drawn primarily from the government sector and major non-government users of travel information and models. The selection was based on the historically predominant users of travel data and travel models. To give some minimal structure to the interviews the follow themes were introduced:

1. Definition of Transport Information and Modeling Systems
2. Key research questions your organisation is interested in at present and in the last few years
3. What use you/your organisation makes of travel data and models in planning and policy formulation
4. Where information is sourced from for planning and policy advice
5. Past experience in accessing particular types of information (frustration and satisfaction) e.g. what it is, who you dealt with, how long it took to get the material and the extent to which the material was suitable or a compromise
6. Your views on the preferred means of accessing travel and transport information or models (a wish list of types of information you/your organisation would find particularly useful)
7. Particular types of information questions which you cannot get answers for
8. General and open discussion - other issues and comments

A discussion paper for prior circulation to participants in client-based workshops was one output of the stakeholder interviews.

Policy issues and links with travel information and model systems

Stakeholders were asked to identify key policy issues important to their organisation today and/or in the future, and which would benefit from information produced from travel surveys and enhancements in the form of interpretative analysis of data and the application of calibrated travel models.

Table 1 lists some of the primary data needs to assist policy development which were emphasised by stakeholders, broadly grouped into (i) descriptions of the current (ie. base) and historical (ie. trend) profiles of spatial travel patterns in the passenger and freight vehicle markets, disaggregated by trip purpose, mode, vehicle type, time of day, day of week, season and socioeconomic class. For freight movements the nature of the cargo by volume and value is added. Multi-way trip tables best describe the outputs; (ii)

forecast 'descriptions' compatible with the base year multi-way trip tables; (iii) interpretative analysis of the descriptive base and trend travel data; (iv) interpretative analysis of *what if...* data, and (iv) prediction and forecast outputs of a decision support system driven by a set of travel, location and vehicle models capable of tracking through the fuller impacts of policies under investigation. The range of outputs of interest are extensive although the critical outputs include impacts (by OD, mode, trip purpose, time of day) on vehicle kilometres, vehicle trips, emissions, government revenue, accessibility, income distribution (i.e. equity) and end user costs.

Many stakeholders desire some analysis of trends in transport and travel over time. Almost all indicated an increased interest in understanding the nature of freight movements, especially the origins and destinations of freight vehicles, and the main routes used. The environment is a high agenda policy issue, related to understanding the contribution of the current transport system to air quality, global warming, noise pollution and damage to property and individuals. Many agencies are increasingly focusing on the relationship between transport policy, movement patterns and urban form (shape, density), which requires a much richer data base of location and travel data than is currently available in transport agencies. The influence of location decisions associated with the supply of jobs, and the release of land for residential, commercial and industrial activity has a profound impact on where people live, where they work, where the commodity flows have to be concentrated, and hence the efficiency of the existing transport system and the needs for further investment.

Three Theme Discussion Statements emerge from this inquiry:

TDS11: Data and Modeling Agencies should develop a wider interpretation of policy-relevant travel data, encompassing the demand-side and supply-side characteristics of activity locations and all transport modes (public and private, passenger and freight)

TDS12: Data and Modeling Agencies should regularly canvass their customer base to ensure that it keeps informed about the important policy issues that require transport information and models

TDS13: Data and Modeling Agencies must give significant weight to the tasks of providing base and trend multi-way trip movement tables, interpretative analysis and reporting as derivatives of the tabular preparation exercise, the development of niche surveys to increase understanding of the impact of policy (what if or scenario surveys), and the development of a decision support system whose behavioural base is a set of location, travel and automobile models capable of evaluating the wider set of policy issues represented by the set in Table 1.

Table 1 Key Policy Linked and Information-Based Issues

Travel Information	**Specific Policy Issues (Illustrative)**
• Travel profiles by OD, trip purpose, time of day, day of week, season, mode and socioeconomic class for base year (and forecast year)	• Role of public transport (vs roads) • Likely impact of pricing policies • Public transport route planning • Knowing one's market and reacting • Potential role of mini-buses/hail n ride) • Evaluation of traffic on existing road links • Evaluation of major projects (eg tollraods, LRT) • Capital works programs • Determine if asset upgrade and/or investment is economically justifiable
• Freight movements (OD) by truck type, cargo type, value and volume	• Freight route evaluation, traffic density • Health/air, noise and water issues • Evaluation of traffic on existing road links • Evaluation of major projects (eg tollroads) Economic connectivity and cost • Determination of generating points • Corridor evaluation studies • Plotting freight routes for operators • Influence of constraints (delivery windows, factory hours etc.)
• Trends in passenger and freight movements Passenger: OD, vkm, trips, vehicle types, by time of day, season, day of week and household type (life cycle, income etc.) Freight: OD, truck type, cargo type, value and volume by time of day, day of week, and season.	• Changing role of public transport • Environmental implications • Impact of changing social patterns on travel (shop opening hours, flexi-time, weekend retailing etc.) • Impact of changing economic conditions on travel-recession, boom times etc. • Social equity issues • Regulatory structures • Microeconomic reform directions, monitoring Understanding past trends to complement the modeling of future trends • Peak spreading and its implications • Development of performance indicators • Setting market share targets in PT agencies (eg. 50% commuter share to CBD) • Impact on and of urban development
• Vehicle kilometres and trips by location (grid square) and vehicle data (age, fuel efficiency), hot and cold starts	• Environmental policy investigations: photochemical smog, greenhouse
• Trends in land use density by type (residential, commercial, industrial etc.) and travel patterns by mode and location	• Transport/land use interaction • Public transport (PT) service planning • Greenfield sites and early role of PT • Implications for the journey to work (where are the jobs by type) • Monitoring urban consolidation and decentralised land use by travel impact
• Residential and workplace location OD activity by time of day and socioeconomic class	• Evaluation of commuter traffic • Spatial/temporal impact of changing work practices Impact of changed work conditions on travel • Changing employment opportunities

• Activity Information to complement trip diaries	• Time spent at the shops, at work, at entertainment locations and implications for parking policy (charges and space)
• What if data (eg stated preferences) for many applications (eg role of LRT, busways, toll roads, congestion pricing, carbon tax, major changes in level and mix of fare classes, alternative densities of residential and workplace locations, regional centre scenarios, job centre scenarios)	• City centres policy • Alternative fuel vehicles • Equity implications of transport policy • Changing patterns of traffic Efficiency implications (revenue, consumer surplus, user cost, accessibility, emissions, energy etc.) • Control strategies to effect changes in air quality (road pricing, fuel taxes, parking restn's etc.)
Understanding past trends to complement the modeling of future trends	• Indicative of urban form and economic activity
Incorporating policy relevant variables in interlinked location/travel and vehicle models: Modeling Systems	• Recognition of interdependencies of land use, travel and environment • To evaluate the complex inter-relationships between land use, travel and the environment (eg impact of alternative land release strategies, rail vs road investment)
• Behavioural understanding of travel/activity patterns (descriptively, interpretation of data, formal modeling of what is and what-ifs) • Attitudinal and opinion surveys	Wide range of policy investigations • Direct and cross elasticities of alternative fare levels and class policies for PT • Competition policy • Deregulation of taxis • What is demand and how do we provide for it.

Data sources and requirements

The primary source of travel data (predominantly urban travel data) for NSW is the Department of Transport's travel surveys (1971, 1981, 1991 and 98-99) and supplementary surveys usually undertaken by consultants and Universities (Wigan and Groenhout 1990, Taylor et al 1992b). The Australian Bureau of Statistics census is useful for a very limited set of travel data on modal split for the journey to work by residential and workplace location, but is totally deficient for the growing non-commuting market (Wigan 1995). Despite this, it is one of the most widely used transport data sources used by the stakeholders because of its ease of access, high quality documentation and support services. The DOT, through its Transport Data Centre (TDC) currently is the only source of travel data with sufficient spatial coverage across all passenger travel and freight movements, and is perceived by stakeholders who are aware of the travel survey activity as the primary source for such detailed travel data.

Desired Future Role for TDC as a Data and Modeling Agency

combined view of the broadening role required of the TDC as the major source of travel data in NSW. Stakeholders see a balance between the responsibility for base travel data collected under the data collection strategy detailed below, interpretative analysis of base data, extensions of base data to incorporate 'what if..." surveys and the development of a modeling strategy embedded within a decision support system capable of integrating revealed and stated preference information. This package of capabilities is designed to ensure that a data and modeling agency is policy useful for the wider set of stakeholders.

An important element of a service delivery strategy is the integrity of any data and modeling agency as a provider of credible information in its various guises. Regardless of the context of service supply, a customer focus is critical. The stakeholders commented extensively about the need for continual improvement in communication and marketing skills. Tabular data will continue to be a requested form of data; however the stakeholders proposed much more flexibility in the way that a data and modeling agency supports requests for a wider range of tables. Tables with more dimensions as suggested in column 1 of Table 1 are needed within a reasonable time period. There is a need to constantly review the structure of data and the relational data bases on the computer system to identify ways of minimising delivery delay. The internet opens up opportunities for very efficient and effective access to information.

Access to unit record data with confidentiality items removed is seen as essential to both expand the opportunities for stakeholders to determine their own interpretative data needs and to undertake model estimation, as well as a measure of confidence in the quality of the travel and network data. Any strategy of suppression, by directive or for whatever means, is frequently interpreted by stakeholders as an expression of the lack of integrity of the data base and by inference, the data and modeling agency (Wigan 1992). Increasingly metropolitan transport agencies worldwide are making unit record data available to the research community, recognising that this is a very cost-effective way of gaining knowledge of the transport system through 'free' model estimation and application activities. Recent examples include Portland and Miami (TMIP 1996a) and the nationwide longitudinal surveys in the USA (Morgan et al 1974).

Emerging Theme Discussion Statements are:

TDS21: Data and Modeling agencies should broaden their obligations to its client base to develop a capability to collect 'what if …' data to supplement the descriptive 'what is…' trip data as well as to reorientate data to emphasis activities rather than trips per se.

TDS22: Data and Modeling agencies should be prepared to stage release data in both tabular and unit record form.

TDS23: Data and Modeling agencies should complement their development of a broader set of more policy useful data bases with an appropriate information strategy to keep its customers well informed.

TDS24: Data and Modeling agencies must be credible to all groups to avoid disaffected groups developing their own data (plus networks, models and forecasts). Rival allegiances to alternative sources of data is counter-productive.

TDS25: Data and Modeling agencies should become the recognised repository for agreed travel and network information.

Beyond basic travel data: other information outputs

In this section we take a closer look at the range of core activities suggested by stakeholders.

Interpretative (Policy) Analysis

In addition to the collection and preparation of base travel data, it is often perceived by stakeholders that data and modeling agencies have historically focused on model development at the possible expense of the opportunity to undertake simple and policy-useful interpretative analysis of the base data. Formal quantitative travel models have an important role, but so does more qualitative interpretation of tabular data. The following example was given by a stakeholder to highlight this distinction:

> *"If the Minister of Transport decides he wants to know what would happen if public transport service levels were improved, what sort of information could he get on the likely impact without resorting to a major modeling activity? Using raw data, we could find out who uses public transport, where they live, and how far they travel. From such data, the Minister could get a view of the likely impact of such a policy. If he wished to pursue it further, some service elasticities could be applied to obtain a partial measure of the likely impact on patronage. It is only at this point, if the Minister still wants to pursue the idea, that the strategic model could be used to look at the wider implications of the policy. "*

This data analysis activity, called *interpretative analysis*, was perceived by many stakeholders as the most frequent analysis they would ever require. Many felt that they had enough trouble obtaining quality data on what was happening now, let alone what might happen in the future, so such interpretative analysis skills were initially what was required from a data and modeling agency. This interpretative analysis is not a substitute for all client interpretative activity. For example, local government often brings an added dimension of interpretation which is not observed at the centre - the "... centre can provide the spanner, and local government transport planners can wield the spanner".

Projections as a Data Interpretative Analysis

Beyond interpretative analysis is another step before formal modeling, called *projection analysis.* Some stakeholders see a role for a data and modeling agency in projecting interpretative analysis on the basis of current trends. These projections could become the default set.

Strategic Travel Models

The final step in the information hierarchy is *strategic planning models.* The view was expressed that many data and modeling agencies have tended to spend too much time estimating and calibrating a very limited set of policy-based travel demand models which are out dated by the time they are available; and are never available in a form which is useful in assisting the policy process.

Model estimation, calibration and application is not well understood by the majority of stakeholders. The historical lack of demonstrating the value of statistical models in applications has given them a dubious reputation. Some stakeholders would like to see more consideration given to making travel models user-friendly and embedded within a decision-support system. This is designed to show how such models can provide information that may complement tabular data and to provide another source of

information to evaluate the many policy issues that are not adequately evaluated through interpretative and trend analysis. The following topics represent examples of useful modeling-based application areas:

The stakeholders expressed the strong view that a data and modeling agency should undertake policy-based modeling and applications as a *pre-emptive activity* so that it is in a good position to contribute to the transport debate in a timely and effective manner. This pro-active (in contrast to re-active) approach will ensure that the suite of model and data needs are kept up to date and are policy-useful. There is a view that a data and modeling agency should move away from the very rigid and highly aggregate travel model system typically in place which have little policy relevance. One stakeholder commented that "... the current four-step model seems lost in the wilderness with no policy-based motivation". Essential to the new paradigm is a richer specification of the set of dependent variables (ie. endogenous variables) in the model system as well as a much larger number of explanatory variables that have links to policy impacts. Most Metropolitan Planning Agencies (MPO's) are struggling with this transition, and very few have made the move (eg Portland, Oregon).

The general lack of awareness of the usefulness of formal planning models is illustrated by a comment from a stakeholder that:

> *"… modeling outputs are nice to have... if they can add value to the current set of transport applications (eg the impact of a new orbital road on land use plans); but that we as stakeholders have limited familiarity with travel models and so are not in a good position to judge both what is available and how suitable it might be for our needs. "*

Stakeholders highlighted a need for greater attention to modeling non-commuting travel activity, with a distinction between discretionary and non-discretionary non-commuting travel. Modeling urban freight activity was also emphasised as a very neglected capability globally. Since externalities (e.g. traffic congestion, traffic noise, air quality and global warming) now play a very central role in transport and land use integration - the need to identify how travel behaviour is influenced by strategies to reduce the externalities is critical to an evolving land-use/transport strategy.

Conventional travel data is essentially descriptive — it needs to be supplemented by data of a scenario or "what if" nature. Indeed the whole issue of more innovative data collection strategies such as stated preference experiments that give new meaning to the evaluation of the big issues was cited many times. One stakeholder stated that "....Stated preference methods must be an essential feature of travel surveys". Armed with enriched advice from the state of the practice tools such as stated preference and revealed preference data based travel demand models which give confidence not only in explaining 'what is...' but also in explaining 'what if...', stakeholders will feel more confident in being able to comment on and/or refute statements made by community and other organisations which are often based on statistics of dubious interpretation.

Spatial Decision-Support Systems: Bringing it all Together into a Policy Useful Operational Tool

Taking stock of all these comments, it seems that what might be required is a set of strategic planning models embedded in a decision support system. It would have to go

beyond the traditional four step travel modeling approach which exogenises many land use and behavioural variables to include locational models, vehicle models, and an expanded set of travel models. The need to broaden the definitions of a travel model system to incorporate locational (ie. land use) and automobile choice models was emphasised. Such a model system, including policy relevant variables, was perceived as being far more useful than the typical agency models because of the ability to ask the big "what if" scenario questions. This would mean that one could look at the wider impacts of decisions, without having to be an expert in all fields.

For example, when deciding whether or not to pursue a policy of urban consolidation, an agency could go to their desktop computer, change urban form in the model structure and then obtain indicative outputs ranging from changes in vehicle kilometres, modal split, noxious gas emissions, accessibility, government revenue and energy consumed. While such results should not be the sole criteria in decision-making, they could at least indicate the *direction of change* and thus be an aid in decision-making. The emphasis on indicative directions of change (with very approximate forecasts) rather than the accuracy of the forecasts was seen as a more appealing way of justifying the value of formal models.

Emerging Theme Discussion Statements are:

TDS31: Data and Modeling agencies should use the travel information base as a pre-emptive policy tool, to not simply provide information but to interpret it. This is a core value added activity.

TDS32: Data and Modeling agencies should move from an almost total emphasis on 'what is…' models to a stronger capability in modeling of 'what if…' . This re-orientation will be more policy-useful.

TDS33: Data and Modeling agencies should develop a strategic level modeling capability in a pro-active mode of policy relevance, to assist the debate on the big strategic issues such as rail corridors, the future of urban consolidation vs decentralisation, road pricing, toll roads etc.

TDS34: A decision-support system in which a behaviourally useful model system is embedded is an essential tool of the Data and Modeling agencies which should be made available to stakeholders and other clients either via advice or on-line.

TDS35: Data and Modeling agencies should develop a staged program of model development, estimation and application in order to ensure that the model system is both policy useful and available to the stakeholders in a timely manner.

Travel surveys: how often and what content?

Government transport agencies have historically focussed on the collection of data over a 10-year cycle, designing a stratified (geographically) random sample travel survey of a large sample of households (Taylor et al 1992, TMIP 1996a). In NSW, the 1971 Sydney survey was specialised to the Sydney metropolitan area; the 1981 and 1991 surveys increased their geographic coverage to include Wollongong, the Central Coast and the Blue Mountains. Commercial vehicle and cordon surveys have complemented the passenger oriented household surveys. The central feature of the latter is a one-day trip diary for each household member and a summary of the socioeconomic characteristics of the household. There is no attitudinal data or 'what if responses. The survey data is processed and weighted up to the sampled population. Together with updated am 2-hour peak traffic data on network levels of service for the highway and public transport system (with no distinction between types of public

transport), a set of traditional travel demand models are estimated and calibrated to the am peak baseline commuter traffic. In 1981 the modal split model was estimated at the individual traveller level but was adjusted extensively by a number of socioeconomic factors to enable the estimated model to be calibrated at the traffic zone level for input into a traffic assignment package such as EMME/2.

The historical experience with data currency limited to a decade cycle has produce two very strong views: (i) base travel data must be meaningful, long lasting, current, regular and free of the political process (at any level of government and bureaucracy) (ii) the 10-year 'big bang' survey strategy should be abandoned in favour of a rolling program of travel data collection, passenger and freight, with a broadening out to accommodate both 'what is...' and 'what if...' information.

There was a strong view that we need regular core data and a capability to undertake specialised surveys as required — "With all money often in the big 10 year survey we are fund-strapped". Treasury is always concerned about the currency of data - credibility requires currency at a level not available from 10 year surveys except in the early years (up to 3 to 4 years). These issues are explored below. The issue of comparisons over time of travel activity was mentioned many times, with a strong desire to support both the creation of a mix of travel surveys (i.e. a household panel (eg Murakami and Watterson 1990), a firm panel, a once-off single cross-section on a niche application etc.) but with an agreed set of definitions of key data to ensure comparability. Better documentation at the time of a survey would avoid the problems of interpretation often faced by users of earlier travel surveys.

The smaller but regular general travel survey might take a number of forms: it could still contain the detail of earlier 10-year surveys but administered to a smaller sample together with other data sources such as a cordon survey to get suitable trip table data (remembering that the costs of data collection are heavily skewed historically towards the self-administered drop-off and collect/check travel survey). This survey can be repeated every 3-5 years or alternatively follow the lead of others surveys such as the VITAL survey in Melbourne which is a continuous survey over time such that each year approximately 6,000 surveys are compiled, giving a rich data base both at a point in time and over time. With a knowledge of sampling theory beyond simple random samples and stratified random samples, it is possible to preserve the richness of data through more sophisticated sampling strategies (e.g. activity-based sampling) and to weight the sampled observations back to a representative sample of the population prior to aggregation to the population as a whole.

Several stakeholders stressed the need for seasonal data, so something along the lines of a rolling 12 month survey could be explored. A popular suggestion was to survey geographical areas in the greatest state of flux more frequently than more stable areas so as to ensure data was as relevant as possible for policy decisions. Table 2 indicates how such a rolling survey program could be structured in terms of timing.

Table 2 Structure of a Rolling Survey Program

	High Predictability	Low Predictability
Stable Area	LEAST OFTEN	
Changing Area	MEDIUM FREQUENCY	MOST OFTEN

The instrument for such a program would initially be a single cross-section, but such a program will undoubtedly lead to repeated cross-sections, and if desired, panel data. It would be much easier to obtain funding for a continuing small survey program than a big survey every 10 years. The NSW Transport Data Centre has since implemented a rolling annual survey program, commencing in 1998. In addition, the use of cordon surveys with a reply-post paid card which requests data on OD, mode, purpose, time of day, vehicle type and travelling party composition is a cost-effective way of securing good spatial data (although doubts were expressed in the workshops about cordon surveys). These few data items are sufficient to generate trip tables for passenger and freight movements.

Emerging Theme Discussion Statements are:

TDS41: Instead of a regular 10 year survey, Data and Modeling agencies should conduct a rolling program of surveys in which areas of greatest flux and/or where change is not so predictable be surveyed more often than more stable or more predictable areas

TDS42: A regular trip-specific cordon survey (reply post-paid card) seeking OD data, trip purpose, mode, trip times etc. is the best way of collecting base spatial data for passenger and freight trips. When complemented by a smaller but regular repeated cross section (RCS) travel survey with 'what is…' and 'what if …' questions and a rotated panel off of the RCS, transport agencies will be able to provide the richest form of data.

Information awareness and dissemination

Five questions were raised many times throughout the discussions: What data is available?, How do I get it?, When do I get it?, What will it cost? and How reliable and credible is it? The most important considerations centred on mechanisms for knowing about the products of a data and modeling agency, how one can access the products and services, the extent, relevance and quality of documentation, and the mechanisms in place to provide ongoing support. Without an appropriate information communication, distribution and support strategy in place, a transport agency is seen by all stakeholders as devoid of a customer focus.

The discussion on the usefulness of various forms of information (including travel models) highlighted an important point - the value of travel models in particular is poorly understood for reasons which cannot be directly attributed to any perception of a transport agencies performance. The issue goes much wider and may be an indictment of the modeling community who seem to have failed in communicating the value of their products. This in part seemed to be attributable to the poor packaging of model systems, a lack of good documentation both of a technical nature and a lay-nature, and

the general absence of a series of courses which can handle the widely varying skills and needs of those who might benefit by the use of travel models if they knew more about what they can help them with. One consequence is a 'fall back' to simple trip tables for tasks which could be better supported by the application of a travel model system. Decision support systems are seen as an opportunity to correct this situation.

Transport agencies need to develop a number of information series (Wigan 1990). A suggested division is (i) technical documentation (explaining the data, the sampling, the data collection process, response rates, weights etc., models and assumptions) of a methodological nature which are of current and historical importance (ii) promotional material indicating what is available and how to obtain information, (iii) travel reports which are short (say 16-20 pages) with lots of graphs and a small amount of interpretation which are prepared by an out-sourced professional publication agency.

Emerging Theme Discussion Statements are:

TDS51: Stakeholders who could benefit from the information collected by the transport agencies had little and often no knowledge of what information was available, and therefore did not use it. The Data and Modeling agencies communications with their client base must improve substantially.

TDS52: The Data and Modeling agencies should develop a marketing strategy which specifically addresses the issue of information awareness and retrieval.

TDS53: Data and Modeling agencies should have a custodial role to provide advice to government, but also to assist others in accessing information and models.

The institutional context

Although we tried to avoid the issue of service delivery source, all stakeholders wanted to make a statement on this. It was recognised that any data and modeling agency if constituted within a government department will have a requirement to satisfy the immediate and ongoing needs of the department in the first instance and then other government departments. The 'closeness' to a department worried many stakeholders — expressing points about access to core data regardless of the political climate of the day, the extent to which a department might swamp the data and modeling agency with referrals for advice which might take it away from what many believe should be the primary roles (i) to collect, prepare and provide core travel data (including networks) and to deliver it to all stakeholders and clients in a timely and efficient manner so that the data is relevant at the time of need, and (ii) to undertake interpretative policy analysis and simple projections of broad stakeholder interest, and the development and application of STIMS which is embedded in a spatial decision-support system.

An important issue is the credibility of information and models. While stakeholders saw it as immaterial where the data and modeling agency resides physically, they were keen to see some peer review mechanisms to ensure that the products of such an agency were relevant, credible, well documented and available to all customers in a timely and efficient manner. The suppression of information was seen as an issue to be discouraged, since it carries very negative connotations in terms of credibility and integrity of an agency and its products. A common view was that unit record data must be made available to the researchers and practitioners, a practice that is very common in some countries, notably in the USA. (U.S. Bureau of Transportation Statistics 1993). Such an expensive and valuable resource needs to be utilised extensively to gain

maximum benefit and to minimise the duplication of effort. Household data is needed by many stakeholders to '...to do our own thing". For example, the location of employment is fractured and scattered. Where are the significant employment locations and how are they trending? We need to access unit records to give flexibility in preparing data to be problem specific.

Emerging Theme Discussion Statements are:

TDS61: The data and modeling agency should release data down to the unit record and take advantage of the intellectual capital available within the client set to assist the data and modeling agency in studying the travel system. This is an essential requirement for credibility and a customer focus.

TDS62: Data should be democratised - the data of the data and modeling agency should be seen as a shared resource, jointly financed by key agencies in the transport sector.

TDS63: The data and modeling agency should not report its activities on an ad hoc basis. A new culture is required which puts pressure on the data and modeling agency to produce useful outputs in a timely manner. A steering committee should review progress regularly (e.g. quarterly).

TDS64: An advisory committee should comprise a mix of stakeholders and experts in the areas of travel data, information and modeling.

Concluding comments on stakeholder interviews

The stakeholder interviews provided the discussion material for a debate in the STIMS workshops. The issues raised are very similar to those debated in the USA as part of the Federal Government's ongoing Transport Model Improvement Program (TMIP 1996):

> *'The travel forecasting models currently in widest use today were developed more than 25 years ago, primarily to evaluate alternative major highway capital improvements. In the 1970s the models were adapted for use in planning major transit capital facilities. These current models were not intended to evaluate congestion pricing, or motor vehicle emissions; so it is not surprising that they are not well-suited to those tasks. "*

The stakeholders were unanimous in the view that a data and modeling agency must be pro-active, develop a commercial sense in the way it runs itself, be policy useful to the broader client base and take advantage of the accumulated store of intellectual capital in the wider transport community. The redesign of a strategic travel information and modeling system should accommodate the needs of the wider stakeholder set through the development, application, reporting and maintenance of the state of practice in travel data collection, its translation into useful information and travel modeling.

The Client Based Workshops

Client-base workshops provide the second stage framework within which the accumulated contributions from the stakeholders were considered, debated and enhanced to arrive at a participatory view of STIMS. The emphasis within the strategy is on both content and context - what should be delivered, over what time frame and resource commitments and how it might be best institutionally and managerially delivered.

Essential to the process of the client workshops, preliminary preparation centred on (i) the discussion paper documented in the previous section (ii) the mechanisms for linking the outcomes required by stakeholders, and (iii) the way in which the outputs of this participation process are used in the development of the strategy for a data and modeling agency's model development. A mix of individuals with a strong commitment to the process were invited to participate. These individuals are stakeholders themselves and representatives of a broader clientele of stakeholders. (Table 3). Three workshops were conducted.

Table 3 Invited Participants in the Client Workshops

Organisation Type
Community Groups
Transport Associations
Transport Research Orgs.
Consultants
NSW State Govt Orgs.
Academics
International
Interstate Govt. Orgs.
Local Government (NSW)
Other

The debate in the workshops followed the same daily pattern. After introductions of participants and a background talk from the Department of Transport, a presentation based on the major components of the discussion paper, distributed in advance, was delivered. The rest of the day concentrated on open discussion with some direction to the debate to ensure that the three key areas of STIMS were adequately addressed; namely the data strategy, the modeling strategy and the information strategy. After lunch, each group was divided into three workshops with the task of developing criteria for a data strategy and a modeling strategy. The findings were reported back to the entire workshop to enable final open discussion before concluding the session.

The major outcomes of the workshops can be divided into a reinforcement of the issues raised in the stakeholder interviews as interpreted in the discussion paper and major enhancements to assist in the development of the core components of a revised STIMS. Importantly the workshops provided an opportunity for the broader set of clients to express their views on the requirements for STIMS to be useful to the client base as a whole. The initial stakeholder interviews went a long way to according with the requirements of the broader client base; however the workshops were essential in order to both confirm this (or otherwise) and to inject some refinement into the issues raised.

This provided the confidence to move forward with the richness of advice from the stakeholder set .

Tapping The International Body Of Expertise

Background

The analytical and applications experts represent the international body of knowledge on the state of the art and state of practice in travel data, networks and models. As a group they provide an important role in both assessing past and present practice as well as the state of the art which will spread into the state of practice over the next 10 years. We undertook an experts' survey in 1995 to synthesise the international state of the art and the state of practice.

An experts' survey involved a first round identification of views of a sample of contributors drawn from mailing lists of various agencies and associations such as the International Association of Travel Behaviour Research, TMIP conference attendees and members of the editorial advisory boarda of the key journals in the field. The views were processed and summarised into key positions that were fed back to the panel in a second round to elicit further comment. This process can in principle continue for a number of rounds, leading to the identification of key consensus and conflict positions. The information sought provides guidance on at least the seven areas set out in Section 2. A formal survey instrument was designed so that there was a common base of information sought Table 4). The set of questions and statements given to the experts sought a sizeable amount of common information from the analytical and applications groups. The experts were asked to comment on tools of design and analysis and also asked for views on how to use data and models to improve the community consensus so as to gain a greater degree of commitment from all parties to the process and emergent issues. Issues of response, communication consultation support and information sharing were also canvassed.

The first round instrument was faxed out to participants in the last week of July 1995. Of the 40 forms faxed out 34 completed forms were returned. Issues addressed as analytic expert goals for the experts' survey include:

1. What can now be achieved?
2. What data is needed to achieve it (and what missing research is required to ensure this is useful?
3. Where are the most vulnerable areas in analytic tools to date?

Issues to be addressed as application expert goals for the experts' survey include:

1. Where has data helped you?
2. What did you wish you had when it did not help?
3. What forms of models and analysis (if it worked) would be most useful? And at what level of detail?
4. How would you suggest making the data collection useful to yourself? And to your organisation?

5. What do you need data and models for most?" consultation, design, strategic planning, consultant use...etc

The second round of the experts' survey provided feedback from both the analytical and application experts outputs (round 1) to both groups, so that cross-fertilisation of the debate evolved. The outcomes would then be more a balance between possibilities and practicalities.

Table 4 Information Sought in the Experts' Survey Activity (Round 1)

Which transport issues have been *most important* in the LAST FIVE years in terms of planning and policy in your country?
Which areas do you believe will be high agenda items over the NEXT FIVE years in your country?
Which OUGHT to receive greater attention in the next 5 years?
Which areas do you think would be best studied via international funding and agencies?
What, in your view, are the range of transport-related skills required to plan and evaluate a transport system/network for a large city?
What software do you/your organisation use?
Where, in your view, does the expertise in your country lie in the following skill areas?
Ideally, where should the expertise lie?
Which areas of expertise do you think should be resident in a State/Provincial Government transport research organisation (even if they are not viewed as the major provider)?
What are the most common frustration's you have faced in accessing information?
Where do you usually get your travel data (for transport planning and evaluation)?
Who collect useful primary data on travel in your country?
What, in your view, are the most important core urban travel data items that should be collected to service the transport planning and research community?
What, in your view, is a desirable mix of data collection strategies for this core data?
For each strategy, how often would you like to see reinterviewing?
RATE the following areas of basic research in terms of their potential impact in applications aimed at *improving* our understanding and forecasting of travel behaviour ?
Rate on a scale of 1 - 10 the following travel models in terms of their relative importance in an integrated model system for *passenger transport*. ?
Rank on a scale of 1 - 10 the following travel models in terms of their relative importance in an integrated model system for *freight transport and commodity demand*. ?
What do you believe are the most important criteria to equilibrate the following model systems?
The following statements provide divergent views on where the state of practice should reside. For each statement please indicate: whether you agree or disagree or have no view whether implementation is feasible today for the approach in (or solution to) the statement (assuming available resources) whether you have implemented the approach (or solution) in recent years (or are in the process of doing so)
Any comments on an issue we may have overlooked
Background Information on Respondent

The findings of the first round of the experts' survey

The major findings from the survey (round 1) are summarised in a number of Tables and Figures, below. One-third of the responses are from Australia, with the USA and the United Kingdom representing 38% of the sample (Table 5). There is a good spread of responses from Western Europe and Chile, the latter being very strong on land use-transport modeling. Approximately 50% of the respondents are academics, 25% are government employees and the balance are consultants (Table 6). Figures 2 and 3 summarise the responses to a series of policy issue questions in which we sought to

identify the most important issues in the last 5 years (Figure 2), and the most important issues over the next 5 years (Figure 3). The issues that ought to receive the greatest attention in the next five years are summarised in Table 7.

Table 5 Country in which respondents work

Country Work In	Number of Respondents	Percentage of Respondents
Australia	12	35.3
Canada	1	2.9
Chile	3	8.8
Germany	1	2.9
Netherlands	3	8.8
Norway	1	2.9
USA	9	26.5
United Kingdom	4	11.8
Total	34	100.0

Table 6 Type of organisation currently employed by

Type of Organisation	Number of Respondents	Percentage of Respondents
University	18	53%
Government	9	26%
Consultant	7	21%
Total	34	100%

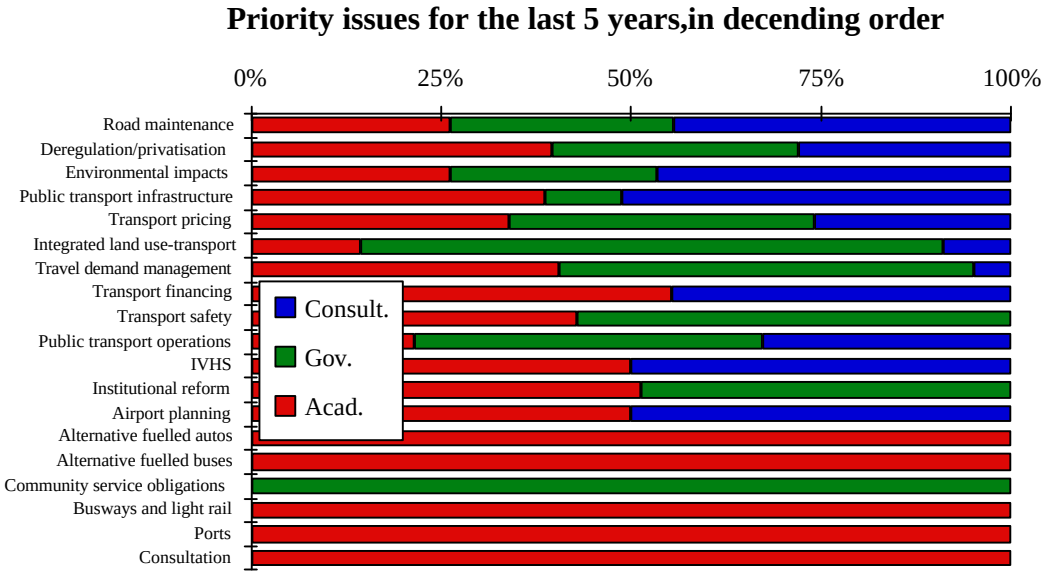

Figure 2 Views of respondents in different sectors as to what were the priority issues in the recent past

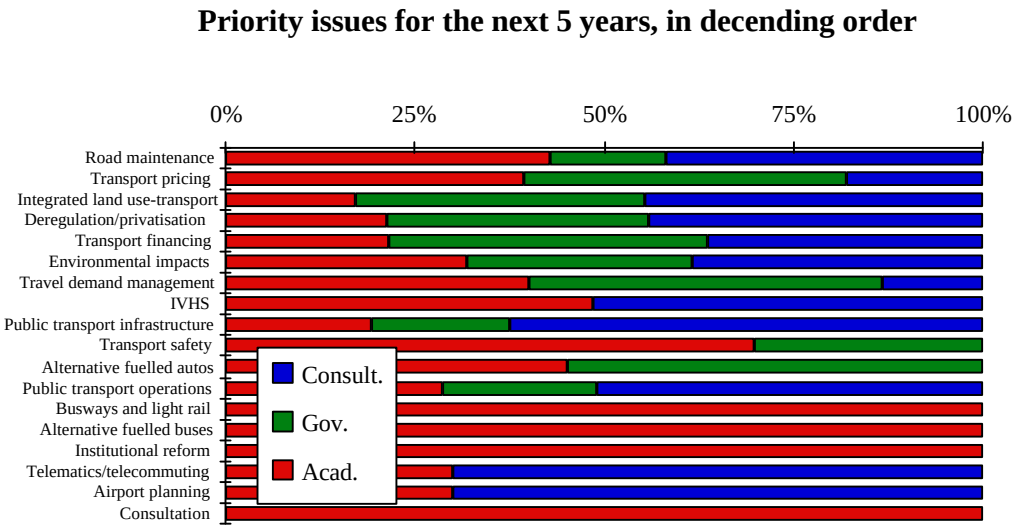

Figure 3 Views of different sectors to priority issues for the near future

Table 7 Priority shifts over time, and a leading indicator of views as to what should take priority in future

Priority	*Observed in the Last 5 years*	*Expected to be for Next 5 years*	*Ought to be for the next 5 years*
1	Road maintenance	Road maintenance	Transport pricing
2	Deregulation / privatisation	Transport pricing	Integrated land use-transport
3	Environmental impacts	Integrated land use-transport	Travel demand management
4	**Public transport infrastructure**	Deregulation / privatisation	Road maintenance
5	Transport pricing	***Transport financing***	Telematics / telecommuting
6	Integrated land use-transport	Environmental impacts	Deregulation / privatisation
7	Travel demand management	Travel demand management	**Public transport infrastructure**
8	***Transport financing***	Intelligent Transport Systems	Transport safety

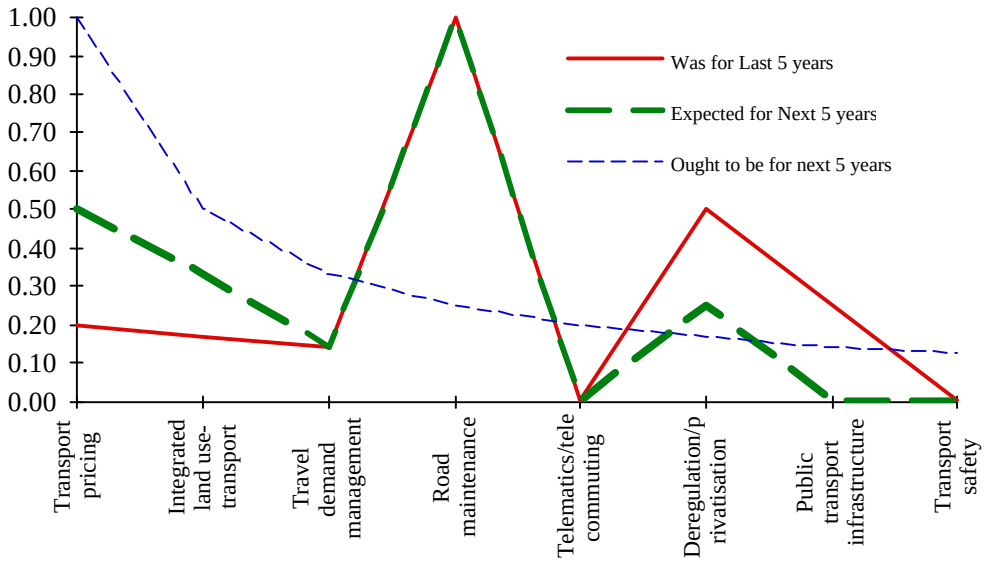

Figure 4 Priority shifts over time, arranged by leading indicator priorities (1 is the highest priority)

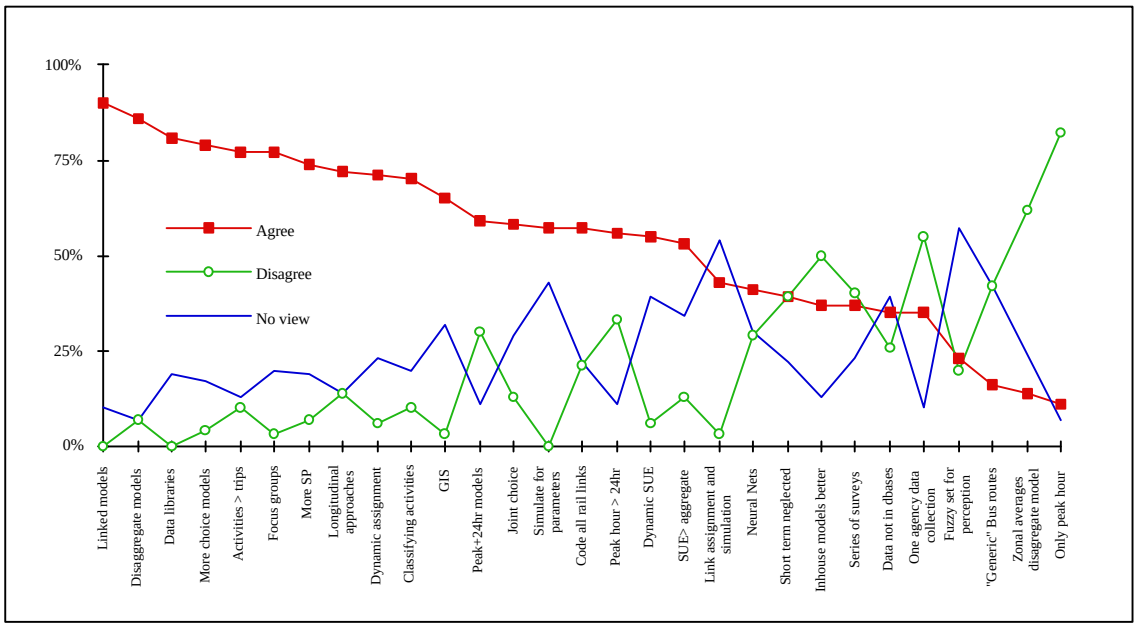

Figure 5 Attitudes towards different types of statements on modeling and data approaches

The results are very informative. Road maintenance has been the most important issue in the last five years and is seen as continuing to be the number one issue. However, there was very strong support for transport pricing and integrated land use-transport planning as the two areas that ought to receive the greatest attention. These latter two policy areas have been in the top six policy areas as most important in the last five years and are likely to continue as high agenda items; although the expert panel would wish to elevate them to the top two positions. Economic and environmental considerations have been and are thought to continue to be high agenda areas of policy, although the panel has repositioned environmental impacts somewhat lower in importance as an area that ought to receive greater attention, implying that it is currently receiving an adequate

level of attention, certainly relative to travel demand management and economic issues such as pricing and deregulation/privatisation. Intelligent transport systems is interpreted similarly to environmental impact. It is also seen to be best studied by international agencies, as indeed are the broad areas of transport pricing and the environment. Telematics and telecommuting move up substantially, reflecting a growing interest in this policy area in contrast to the past and current agendas.

The dominating role of road maintenance in the last five years and in the next five years is being put aside to promote more efforts in pricing, integrated transport and land use, and travel demand management. This reflects a growing interest in a more multi-modal approach to transport planning with a stronger emphasis on land use implications. There is a view overall however that efforts to date and in the next five years to improve public transport infrastructure are well established on the policy agenda - what we need is *more* emphasis on pricing, land use and demand management. The same argument applies to transport financing which is being given adequate treatment. Support for greater levels of consultation (compared to the recent past) is also apparent, even though it is not seen as important as the economic issues. Data and modeling agencies are well positioned to contribute to the development of a modeling system which can assist the debate on alternative land use-transport strategies with a number of alternative scenarios for pricing and travel demand management.

Table 7 showing priority shifts is complemented by Figure 4 showing the changes in views over time in order of rated priorities by the experts in their own view. The points below the 'ought to be' line are the areas where the expected priorities are felt likely in practice to be set too low, and those above where they were (or are expected to be) set too high. The expressed views towards various research and model development areas provide one aspect of the expert opinion consensus, but does not clearly indicate the directions where choices are likely to be made. To probe this a series of weighted questions were included to elicit opinions of this kind. Initially it was felt that the survey had only mixed success in doing this, but when the responses are arranged in decreasing order of agreement (Figure 5), the patterns become clearer.

There is a high degree of agreement on several issues. Traffic and travel demand models need to more closely linked, greater use of dissagregate choice models, and an emphasis on activities rather than trips. Dynamic assignment, and classifying activities into mandatory, flexible and optional and using longitudinal surveys more were also supported. The need for transport data libraries was strongly endorsed, with no recorded disagreements at all. The use of GIS (Geographical Information Systems) for modeling and data management was widely recognised as important. Few respondents were in favour of using only peak hour models, coding only generic bus routes, and keeping data in a simplified format and outside data management systems.

Table 8 summarises the expert’s views on where the expertise lies in each respondent's own country on 20 skill areas. Table 9 summarises where the panel believes that the expertise ought to lie, distinguishing between the current organisational status of the respondents. Overall, the perceived expertise currently in most skill areas is seen to lie with consultants and Universities, in contrast to all levels of government. Highway networks stand out as a competitive edge in expertise within the State government sector. Table 8 suggests that Universities currently have the greatest amount of expertise in the design of surveys, samples and questionnaires, as well as model estimation, calibration, forecasting and application. Consultants appear to have an advantage in date

collection, editing, entry, preparation and management, as well as public transport networks. The distinction between survey design, data collection/preparation, and model estimation/application is quite pronounced. The Federal government sector is virtually equal billing with the Universities and the consultants in policy analysis, with State government and local government falling behind in this area.

When we consider the views on where the expertise lies (Table 9), we see some movement in the contemporary positioning of each organisational type. The consultants gain the high ground in all areas of survey design and data collection, although the government sector is encouraged to be more involved in data management, networks, model application, project evaluation and project management. The estimation and calibration of models seems to invoke a passionate sense of ownership by each organisational type. Overall, the views support the proposed emphasis of a data and modeling agency to manage the survey and data aspects of STIMS, outsourcing the survey design and data collection as well as model estimation and calibration. The role of the government as the key data manager is noted.

Government respondents showed an emphasis on land use-transport and transport pricing, probably reflecting concern over the increasing difficulties in financing new infrastructure, and the necessity to have a sound integrated planning framework to maintain control as more partnership and private finance is used.

Table 8 Expertise of different organisations (1 = very good, 20 = very poor). (Figures are mean ratings, with standard deviation in brackets)

Skill Area	Fed Govt	State Govt	Local Govt	Unis	Subs Res Orgs	Consultants
Project management	5.17 (2.69)	4.63 (2.69)	5.04 (1.87)	6.30 (2.49)	4.73 (2.69)	3.13 (1.87)
Survey design	6.14 (3.00)	6.75 (2.91)	7.09 (2.27)	3.00 (2.00)	3.67 (2.32)	3.92 (1.98)
Sample design	6.00 (2.93)	6.88 (2.85)	7.57 (2.09)	3.00 (2.28)	3.47 (2.29)	4.00 (1.98)
Questionnaire design	5.86 (2.98)	6.50 (2.94)	7.09 (2.43)	3.04 (2.24)	3.60 (2.64)	3.87 (2.17)
Data collection	6.10 (2.68)	6.13 (2.85)	6.52 (2.34)	4.48 (2.52)	4.27 (2.74)	3.33 (2.08)
Data editing and entry	6.44 (2.73)	5.93 (2.79)	7.11 (2.25)	4.15 (2.48)	4.27 (2.74)	3.41 (2.06)
Data preparation	6.37 (2.67)	6.00 (2.90)	6.95 (2.12)	4.05 (2.31)	4.13 (2.50)	3.57 (2.02)
Data management	6.48 (3.03)	5.94 (2.92)	6.68 (1.91)	4.24 (2.21)	4.93 (2.46)	3.78 (2.52)
Highway networks	5.57 (2.69)	3.95 (2.09)	5.27 (2.39)	5.24 (2.47)	6.75 (1.96)	4.09 (1.81)
Public transport networks	5.95 (2.82)	5.22 (2.62)	6.24 (2.68)	4.81 (2.29)	7.17 (1.85)	4.30 (2.12)
Model estimation	6.45 (2.65)	6.94 (2.33)	7.82 (2.17)	2.87 (2.38)	4.93 (2.73)	3.88 (1.57)
Model Calibration	6.45 (2.76)	6.76 (2.41)	7.55 (2.18)	3.22 (2.66)	5.00 (2.63)	3.75 (1.67)
Travel forecasting	6.13 (2.63)	6.50 (2.22)	7.55 (2.46)	3.50 (1.92)	5.07 (2.40)	3.63 (1.84)
Training	6.15 (2.32)	6.69 (2.60)	7.65 (2.11)	2.84 (2.46)	5.77 (2.01)	4.91 (1.81)
Model application	5.73 (3.10)	5.89 (2.52)	6.45 (1.95)	3.43 (1.43)	4.71 (1.98)	3.46 (1.79)
Transport economics	4.61 (2.19)	6.31 (3.05)	8.05 (1.93)	3.09 (2.43)	4.64 (2.02)	4.45 (2.13)
Consultation	6.85 (2.41)	6.64 (3.00)	5.90 (3.26)	4.76 (2.19)	5.15 (1.91)	3.40 (2.19)
Project evaluation	5.09 (2.50)	5.33 (2.74)	6.55 (2.24)	4.86 (2.48)	6.00 (1.65)	3.61 (1.97)
Policy analysis	4.20 (2.80)	5.22 (2.53)	6.82 (1.74)	4.50 (2.00)	5.47 (2.00)	4.52 (1.83)
Tabular analysis	4.50 (1.86)	4.73 (2.15)	5.93 (1.73)	3.20 (1.61)	4.00 (2.05)	3.29 (2.02)

Table 9 Ideally, where should the expertise lie for the following skill areas by the organisation the respondent is employed by (most frequent response reported, top 2 in the case of a tie)

	Organisation Respondent works for		
Skill Area	**University**	**Government**	**Consultant**
Project management	Govt	Govt	Govt
Survey design	Cons	Govt/Cons	Cons
Sample design	Cons	Cons	Cons
Questionnaire design	Cons	Cons	Cons
Data collection	Cons	Cons	Cons
Data editing and entry	Cons	Cons	Cons
Data preparation	Cons	Cons	Cons
Data management	Govt	Govt	Uni
Highway networks	Govt	Govt	Govt
Public transport networks	Govt	Govt	Govt
Model estimation	Uni	Govt	Cons
Model Calibration	Uni	Cons	Cons/Uni
Travel forecasting	Govt	Govt	Cons
Training	Uni	Govt	Uni
Model application	Govt/Cons	Govt	Cons
Transport economics	Govt/Uni	Govt	Uni
Consultation	Govt	Cons	Cons
Project evaluation	Govt	Govt	Govt
Policy analysis	Govt	Govt	Govt
Tabular analysis	Cons	Govt/Uni	Cons

Table 10 summarises the most common sources of frustration in accessing information from each of the three agency types. The items identified in the government sector are echoed in the stakeholder and workshop commentary. The addition of concerns from other participating organisations add another dimension - problems do occur outside of the government sector, most notably in areas of documentation, expense, organisation and property rights.

Table 10 Common frustration's accessing data from various agencies (listed in order of frequency of response)

Government	**Private Data Agencies**	**Universities**
Delays in access	Expense	Lack of documentation
Confidentiality restrictions	Data too specialised	Disorganised approach
Poor staff response	Poor documentation	Inappropriate data
Knowledge of what is available		Uncertain property rights
Expense		

Participants were asked to rate over 30 areas of research in terms of their potential impact in applications aimed at improving our understanding and forecasting of travel behaviour. To enable us to identify the hierarchy of travel models in an integrated model system, the panelists were asked to rate various models in the application

contexts of non-commuting, commuting, household activities, firm activities and freight/commodity movements.

The research areas have a mean rating varying from 3.5 to 7.9 on a 10 point scale. Activity modeling, stated preference methods, location based choice models and the implementation of a GIS spatial database lead in relative importance. All of these research areas were referred to on many occasions by stakeholders and participants in the workshops. The correspondence between the three consultation instruments is most encouraging. The next set of research areas were joint modeling of stated and revealed preferences, measuring accessibility, dynamic traffic assignment and travel market segmentation. Once again, these topic areas reflected a broad view on where the main action should be focussed - dynamic traffic assignment accords with the interest in trip timing and peak spreading, travel market segmentation reflects the concern expressed in the workshops that we need to develop more useful market segments to reflect the growing complexity of activity and travel behaviour.

While not denying the relative importance of other listed topic areas (16 additional areas with an average rating greater than 5.0), the evidence from the experts' survey (round 1) supports a focus on activities rather than trips per se, richer market segments for activity differentiation, the ability to accommodate a much wider set of travel and location choices, supported by stated preference data which enable the analyst to enrich the revealed preference data in contexts which are not readily observed in the market but which may be supportable in future land use-transport strategies, and the need to use GIS as an integrating and presentational tool.

The final section of the experts' survey sought opinions on 29 statements. Respondents were asked to agree, disagree or express no view on each statement (Table 11). They were also asked to indicate whether they thought that implementation is feasible today for the approach in each statement (Table 12), and whether they have implemented any of the policies underlying each statement (Table 13). Agreement with each statement varied from 11% to 90%. The most agreeable statement was 'traffic simulation and travel demand models should be linked'(statement 8). The least agreed to statement was 'a city only needs a peak hour model'. Once again we see here evidence to support a trip timing choice model, dynamic traffic assignment and the integration of travel and traffic models into a spatial decision support system associated with a GIS architecture so that results can be presented at all levels of spatial detail in respect of traffic movements. The 'no view' response was as high as 57% for 'fuzzy set theory should be used to model user perceptions' and as low as 7% for 'a city only needs a peak hour model' and 'models such as mode choice should be disaggregate'. A careful assessment of the results in Table 11 will confirm the support from analytical and applications experts for an approach to modeling which is flexible in the level of disaggregation of data and model estimation, which also spawns a widening set of behavioural models to reflect the impacts of peak spreading and non-commuting activity, and which promotes the ideas of longitudinal data, stated preference methods and activity-based approaches to modeling travel behaviour.

In evaluating the feasibility of translating state of the art ideals into practice, there is strong support that much can be achieved. Feasibility across the set of statements varies from a low of 76% to a high of 100%. Indeed in the areas of interest for the data and modeling agency's strategy which have been highlighted in all dimensions of the consultation process, the level of feasibility as indicated by the expert panellists is in

excess of 90% except for dynamic traffic assignment (87%) and activity data and models compared to trip-based approaches (76%). The activity approach however had the fourth highest percentage of 'agrees' suggesting that it is an important strategy. The statement combines activity data and activity models, the latter being the real challenge. The support of the consultation participants is essentially in the area of activity diaries with more conventional behavioural model specifications.

Table 11 Where should the state of practice lie?

Statement	Agree	Disagree	No view
Activity data & models more useful than trip-based approaches	77%	10%	13%
Longitudinal data & models should replace static approaches	72%	14%	14%
Focus groups useful to understand hhld decision making	77%	3%	20%
Should be greater use of SP questions in surveys	74%	7%	19%
GIS should be used for dbase management and model integration	65%	3%	32%
Data should be held in simple forms rather than dbases	35%	26%	39%
Stochastic simulation should replace deterministic agg extrap	53%	13%	34%
Traffic simulation and travel demand models should be linked	90%	-	10%
The use of disaggregate choice models should be expanded	79%	4%	17%
Simulations should be used to develop stable travel model params	57%	-	43%
Joint choice decisions should be modelled in preference to sequential models for many travel choices	58%	13%	29%
A city only needs a peak hour model	11%	82%	7%
A city needs both a 24hr and peak hour model	59%	30%	11%
Models such as mode choice should be disaggregate	86%	7%	7%
Disaggregate models should use zonal averages	14%	62%	24%
Stochastic user equilibrium should be extended to dynamic assignment	55%	6%	39%
Current traffic assignment should be replaced by dynamic assignment processes	71%	6%	23%
Peak hour models are a better option than 24hr models	56%	33%	11%
Traffic assignment models should be linked with traffic simulation	43%	3%	54%
Every rail line should be coded on the network	57%	21%	22%
Bus routes should be represented as “Generic” routes to reflect a corridor	16%	42%	42%
Fuzzy set theory should be used to model user perceptions	23%	20%	57%
Use of neural networks (or similar) should be expanded	41%	29%	30%
Classifying activities into mandatory, flexible and optional is behaviourally useful way to recognise possible variability	70%	10%	20%
Developing in-house models rather than purchasing models leads to better forecasting/planning	37%	50%	13%
There should be a transport research data library established in each country which can be accessed worldwide	81%	-	19%
Core travel data for an urban area should be collected by one agency	35%	55%	10%
Short and medium term forecasting often neglected in favour of long term forecasting	39%	39%	22%
Travel surveys should evolve from single large survey to a series of smaller integrated surveys usually with a single goal	37%	40%	23%

Table 12 Is implementation feasible today?

Statement	Feasible	Not Feasible
Activity data & models more useful than trip-based approaches	76%	24%
Longitudinal data & models should replace static approaches	92%	8%
Focus groups useful to understand hhld decision making	100%	
Should be greater use of SP questions in surveys	96%	4%
GIS should be used for dbase management and model integration	96%	4%
Data should be held in simple forms rather than dbases	100%	
Stochastic simulation should replace deterministic agg extrap	94%	6%
Traffic simulation and travel demand models should be linked	91%	9%
The use of disaggregate choice models should be expanded	100%	
Simulations should be used to develop stable travel model params	94%	6%
Joint choice decisions should be modelled in preference to sequential models for many travel choices	90%	10%
A city only needs a peak hour model	96%	4%
A city needs both a 24hr and peak hour model	100%	
Models such as mode choice should be disaggregate	96%	4%
Disaggregate models should use zonal averages	95%	5%
Stochastic user equilibrium should be extended to dynamic assignment	80%	20%
Current traffic assignment should be replaced by dynamic assignment processes	87%	13%
Peak hour models are a better option than 24hr models	100%	
Traffic assignment models should be linked with traffic simulation	100%	
Every rail line should be coded on the network	100%	
Bus routes should be represented as “Generic” routes to reflect a corridor	100%	
Fuzzy set theory should be used to model user perceptions	78%	22%
Use of neural networks (or similar) should be expanded	93%	7%
Classifying activities into mandatory, flexible and optional is behaviourally useful way to recognise possible variability	100%	

Figure 6 summarises the implementation profile of the participants in respect of the items in the statements. There is a relatively high incidence on non-implementation (ranging from 100% for fuzzy set theory to 38% for peak hour models). Typically over 40% of the respondents have implemented, or are in the process of implementing, many of the approaches listed. This question must be handled carefully because many of the participants are specialist researchers who do not actively undertake research in many of the areas although they have an appreciation of their relevance.

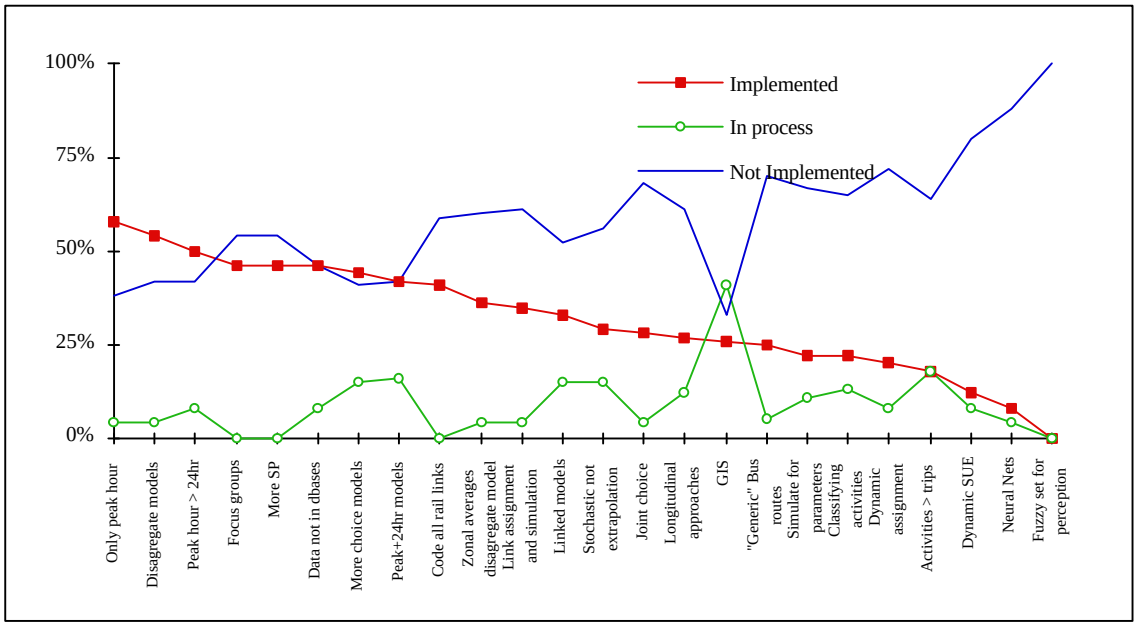

Figure 6 Where have we got to in applying a range of identified modeling and data area

Table 13 Have you implemented these policies?

Statement	Imple-mented	In process of impl	Not Imple-mented
Activity data & models more useful than trip-based approaches	18%	18%	64%
Longitudinal data & models should replace static approaches	27%	12%	61%
Focus groups useful to understand hhld decision making	46%	-	54%
Should be greater use of SP questions in surveys	46%	-	54%
GIS should be used for dbase management and model integration	26%	41%	33%
Data should be held in simple forms rather than dbases	46%	8%	46%
Stochastic simulation should replace deterministic agg extrap	29%	15%	56%
Traffic simulation and travel demand models should be linked	33%	15%	52%
The use of disaggregate choice models should be expanded	44%	15%	41%
Simulations should be used to develop stable travel model params	22%	11%	67%
Joint choice decisions should be modelled in preference to sequential models for many travel choices	28%	4%	68%
A city only needs a peak hour model	58%	4%	38%
A city needs both a 24hr and peak hour model	42%	16%	42%
Models such as mode choice should be disaggregate	54%	4%	42%
Disaggregate models should use zonal averages	36%	4%	60%
Stochastic user equilibrium should be extended to dynamic assignment	12%	8%	80%
Current traffic assignment should be replaced by dynamic assignment processes	20%	8%	72%
Peak hour models are a better option than 24hr models	50%	8%	42%
Traffic assignment models should be linked with traffic simulation	35%	4%	61%
Every rail line should be coded on the network	41%	-	59%
Bus routes should be represented as “Generic” routes to reflect a corridor	25%	5%	70%
Fuzzy set theory should be used to model user perceptions	-	-	100%
Use of neural networks (or similar) should be expanded	8%	4%	88%
Classifying activities into mandatory, flexible and optional is behaviourally useful way to recognise possible variability	22%	13%	65%

The findings from the first round of the experts' survey were fed back to the 34 participants in a second and final round. Each participant was invited to comment on each set of findings by providing an open ended comment on each Table and Figure. The aim was to elicit any particular view in relation to contents as part of establishing any variations in views which might qualify the interpretations above. The feedback form, mailed out in late September, gave almost unanimous support for the material harnessed in round 1.

Conclusions And The Future

Managing the transport assets of an urban economy and ensuring that change is in accordance with suitable performance measures requires continuing improvement in supporting analytical power and empirical information. One crucial input in any ongoing review of data and modeling capability for improving planning and policy support is a recognition of the role of stakeholders and the impact they can have in supporting the ongoing commitment to implementing a state of practice data and modeling strategy.

The recommendations from this review process have largely been acted upon in NSW for passenger transport but remain a challenge for urban freight. There is now an active program of ongoing data collection with approximately 3,000 home interviews undertaken annually in Sydney since 1999. In addition a new Sydney Travel Model capability utilising this new household data and updated highway and public transport networks for five times of day has been designed. Components of the new model system have been finalised at the end of 1999, with a focus on car ownership and driving licence holdings, as well as trip frequency, trip destination and mode choice for the journey to work tours. On going implementation of a non-work travel capability commenced in 2000. To ensure continuous relevance of the data and modeling process, a permanent technical advisory group is in place with representation from the key stakeholders.

This paper has presented a multi-stage stakeholder assessment of data and modeling needs (primarily in the urban passenger context) that is required to ensure the continuity of appropriate deliverables to a market of diverse stakeholders. The implementation of the framework of inquiry enables data and modeling agencies to remain current and relevant. Such an exercise should be encouraged from time to time as part of good practice.

Good practice in data collection would support an ongoing survey process that guarantees the timeliness and representativeness of activity data in general and travel data in particular. The data should be sufficiently rich to capture the diversity of behavioral responses to the transport systems offerings (notably responses to traffic congestion). Such data should include a mixture of description of current activity as well as stated response data that enables analysts to gauge the degree of behavioral sensitivity to policies that offer opportunities and solutions outside the domain of market experience.

Although it might be argued that there is sufficient stability in individual preferences, constraints and likely behavioral responses to limit data collection to regular periods (eg every 5 years), there are other good reasons for promoting an annual survey process. The most important reason is budgetary and the flow through implications on the resourcing of expertise to maintain its currency of knowledge of data and modeling. It is easier to secure smaller sums of financial support annually than to seek a substantial financial commitment periodically.

With new technologies now available to track activity and travel behavior (eg GPS systems and the internet), the future strategies for data collection per se are likely to be a mixture of direct and indirect methods. In selecting a data collection method, one has to recognise that although one can track actual travel movements of an individual or a vehicle using GPS-linked systems (as in TRANSIMS), essentially replacing paper and pencil cordon surveys, an understanding of behavior and behavioral response requires direct contact with a respondent. The internet offers real promise in geographical settings where the internet is widespread (replacing the telephone and fax as the future communication medium). The ability to provide attractive survey forms and real time data capture methods via the internet makes it the prime contender for ongoing data collection in both passenger and freight activity.

The accumulation of ever-rich data for descriptive interpretative analysis and formal modeling as well as the growing desire by stakeholders for direct access to outputs (and in some cases to the entire data and modeling process) will require more sophisticated data management systems than we currently have. In particular, the internet will become a central mechanism for documentation and access to the data systems and models, eventually facilitating the application of the travel model system directly from the internet (possibly by a subscription service to at least recover the value-added element).

References

Dueker, K. and Ton, T. (2000) Geographic Information Systems, in Hensher, D.A. and Button, K. (eds.) *Transport Modeling*, Handbooks in Transport Volume 1, Pergamon Press, Oxford, Chapter 15.

Hensher,D.A. and Greene, W.H. (1999) Specification and estimation of nested logit models, Institute of Transport Studies, The University of Sydney, May.

Louviere, J.J., Hensher, D.A. and Swait, J. (2000) *Stated Choice Methods: Analysis and Applications in Marketing, Transportation and Environmental Valuation*, Cambridge University Press, Cambridge.

McFadden, D.L. (1981) Econometric models of probabilistic choice in *Structural Analysis of Discrete Data*, Manski, C.F. and McFadden, D.L. (eds.) MIT Press, Cambridge Massachusetts, 198-271.

Morgan, J.N., Dickinson, K., Dickinson, J., Benus, J. and Duncan, G. (1974) Five Thousand American Families - Patterns of Economic Progress, Ann Abor, Michigan, *Survey Research Centre, Institute for Social Research*, The University of Michigan.

Murakami, E. and Watterson, W.T. (1990) Developing a household travel panel survey for the Puget Sound region, *Transportation Research Record*, 1285: 40-46.

Taylor, M. A. P., Young, W. F., Wigan, M. R., & Ogden, K. W. (1992a). Designing a large-scale travel demand survey: new challenges and new opportunities. *Trans.Res.A*, 26(3), 247-262.

Taylor, M. A. P., Young, W. F., Wigan, M. R., & Ogden, K. W. (1992b). Travel data: their collection and use. In E. S. Ampt, A. J. Richardson, & A. H. Meyberg (Eds.), *Selected readings in transport survey methodology* (pp. 351-371). Melbourne: Eucalyptus Press.

TMIP (1996) Travel Model Improvement Program Conference Proceedings, August 14 to 17, Fort Worth Texas.

TMIP (1996a) Scan of Recent Travel Surveys, Travel Model Improvement Program U.S. Department of Transport, Washington D.C., June.

US Bureau of Transportation Statistics. (1993). Transportation Data Sample. Publication BTS-CD-01 (CD Rom in ISO 9660 format)

Wigan, M.R. and Groenhout, R. (1990). How much is it worth to have strategic travel and transport demand information? In *15th Australian Road Research Board Conference*, 6 (pp. 127-146). Darwin, NT:

Wigan, M. R. (1990). How do we tie the transport information we need together and deliver it? In *15th Australasian Transport Research Forum*, 2 (pp. 319-330). Sydney: