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

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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 for improving planning and policy support in urban transport in an ongoing review of data and modeling capability is a recognition of the role of stakeholders and the impact they can have in supporting the commitment to implementing a state of practice in data and modeling strategy. This paper presents a multistage stakeholder assessment of data and modeling needs in Australia, primarily in the urban passenger context, 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.

BACKGROUND

An important task in the development of a Strategic Travel Information and Model System (STIMS) is to establish efficient and effective links between the needs of stakeholders and STIMS. The details of the specific analytical tools are secondary

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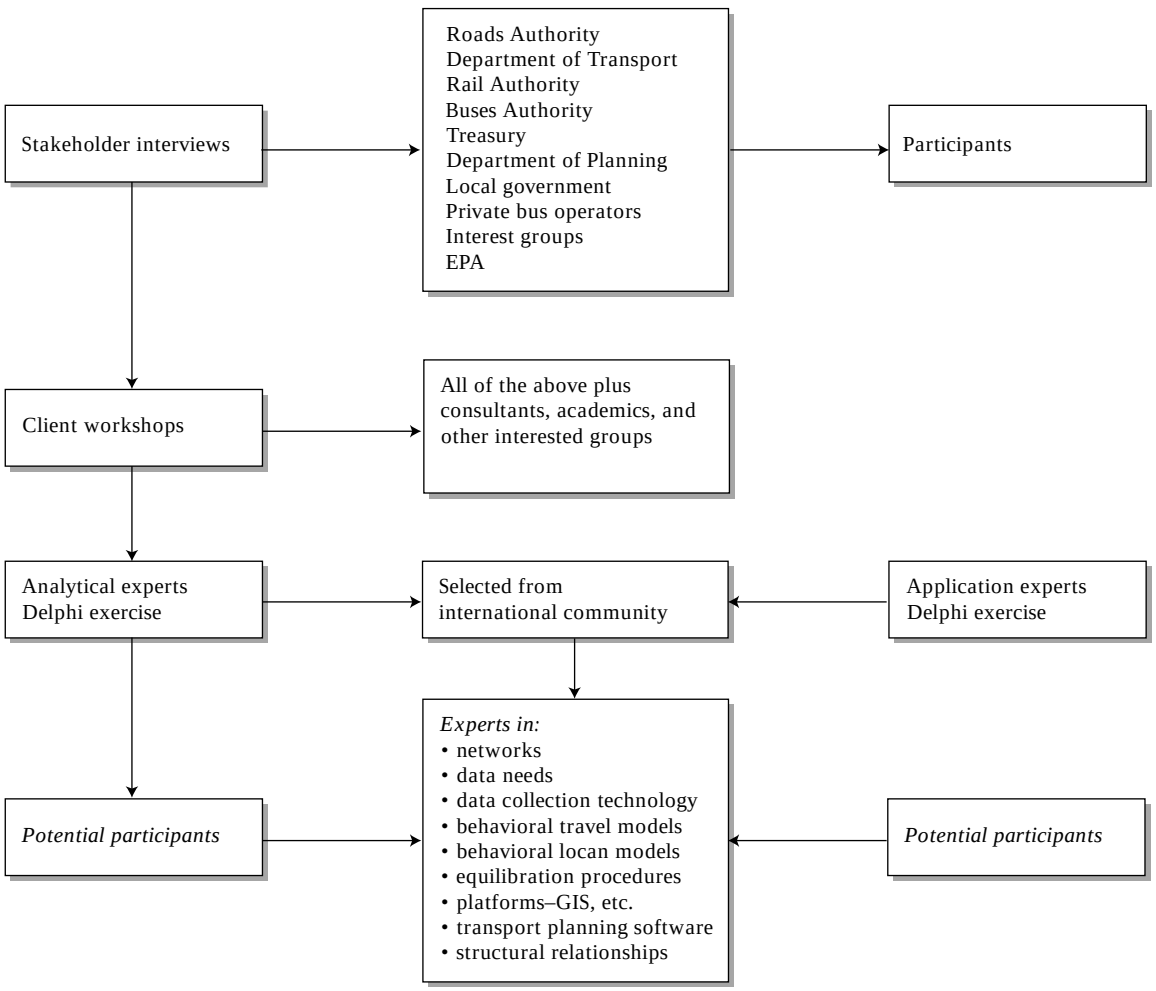
to this objective, representing the translation of needs into relevant models and supporting data. For example, a need may be as simple as data on the number of passenger vehicles, by vehicle type, using tolled motorways in an urban area. This is a descriptive statement of actual vehicle flows, a data need that requires appropriate statistical presentation and supporting documentation. Another need may be more generic, such as an interest in local air pollution and the ability to identify what policy instruments (transport and nontransport 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 his or her own analytical model system.

These examples highlight a main challenge for a strategic travel information and model system. The system 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 output from a detailed travel forecasting model system. One useful starting point for the process of the 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), the clients, and the body of analytical and application expertise. The contribution of these players can be captured by a consultative context as summarized schematically in figure 1. The stakeholders, the wider client base, the analytical experts, and the application experts

FIGURE 1 Consultative Context Design



all bring to the design process necessary perspectives on the state of knowledge and its relevance at various layers of decisionmaking.

Each consultative instrument has a very specific objective:

- Stakeholder interviews: To identify the policy-based obligations of an organization and the role that travel and transport information plays and could contribute to the planning and decisionmaking process.
- Client workshops: To enrich the perspectives of stakeholders and the "experts" by identifying, through debate and discussion, the broader informational needs of stakeholders and other clients in the chain of participation in transport planning and decisionmaking and to identify the most effective way of delivering the products.
- Analytical and application experts activity: To identity the state of the art and practice in areas of information associated with travel models and travel data and to establish the link between the state of play and its relevance to the transport planning and decisionmaking process.

An important distinction exists between analytical and application experts. The latter have often "evolved" from the former, moving away from basic and nonpolicy-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 its activities yet with a wealth of knowledge of the appropriateness of analytical and data tools in servicing the needs of a client base. In contrast, analytical experts include researchers whose primary goal is the advancement of the state of knowledge with a 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.

THE STAKEHOLDER INTERVIEWS

Background

A face to face interview was undertaken in New South Wales (NSW) with 12 key stakeholders drawn primarily from the government sector and major nongovernment users of travel information and models. The selection was based on the historically predominant users of travel data and travel models. To give a minimal structure to the interviews, the following themes were introduced:

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

A discussion paper for prior circulation to participants of 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 organization today and/or in the future. They were also asked how they 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 for assisting policy development emphasized by stakeholders. They are broadly grouped into five areas.

TABLE 1 Key Policy-Linked and Informtion-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 (e.g., tollroads, 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 (e.g., 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 public transport (PT) agencies (e.g., 50% commuter share to CBD) • Impact on and of urban development
• Vehicle kilometers 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 decentralized land use by travel impact

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TABLE 1 Key Policy-Linked and Informtion-Based Issues *(continued)*

Travel information	Specific policy issues (illustrative)
• 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 shops, at work, at entertainment locations, and implications for parking policy (charges and space)
• What if data (e.g., stated preferences) for many applications (e.g., 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 center scenarios, job center scenarios)	• City centers 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, restaurants, 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 interrelationships between land use, travel, and the environment (e.g., impact of alternative land release strategies, rail vs. road investment)
• Behavioral 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 public transport (PT) • Competition policy • Deregulation of taxis • What is demand and how do we provide for it

The first area consists of descriptions of the current (base) and historical (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 output. The second area contains forecast "descriptions" compatible with the base year multi-way trip tables. The third area is interpretative analysis of the descriptive base and trend travel data. The fourth area is an interpretative analysis of "what if . . ." data, and the fifth area is made up of prediction and forecast output 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 output of interest is extensive, although the critical output includes impacts (by origin-destination, mode, trip purpose, time of day) on vehicle-kilometers, 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 priority 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 database of location and travel data than is currently available in transport agencies. Location decisions associated with the supply of jobs and the release of land for residential, commercial, and industrial activity have a profound impact on where people live, where they work, and where the commodity flows must be concentrated and, therefore, on the efficiency of the existing transport system and the needs for further investment.

Theme Discussion Statements emerging 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 canvas their customer base to ensure that they keep 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, offering interpretative analysis and reporting as derivatives of the tabular preparation exercise, developing niche surveys to increase understanding of the impact of policy ("what if . . ." or scenario surveys), and developing a decision support system whose behavioral base is a set of location, travel, and automobile models capable of evaluating the wider set of policy issues represented in table 1.

Data Sources and Requirements

The primary source of travel data (predominantly urban travel data) for NSW is the Department of Transport's (DOT's) travel surveys (1971, 1981, 1991, and 1998–99) as well as 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 deficient for the growing noncommuting market (Wigan 1990). Despite this, it is one of the most widely used transport data sources by stakeholders because of its ease of access, high quality documentation, and support services. The DOT, through its Transport Data Center (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 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

The diverse policy issues documented in table 1 represent the stakeholders' combined view of the broadening role required of the TDC as the major source of travel data in NSW. Stakeholders would like to 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 focus on customers 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 a greater 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 databases on the computer system to identify ways of minimizing 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 expanding the opportunities for stakeholders to determine their own interpretative data needs and to undertake model estimation. This access is also essential as a measure of confidence in the quality of the travel and network data. Any strategy of suppression, by directive or other means, is frequently interpreted by stakeholders as an expression of the lack of integrity of the database and, by inference, of the data and modeling agency (Wigan 1990). Increasingly, metropolitan transport agencies worldwide are making unit record data available to the research community, recognizing 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 (USDOT 1996) and the nationwide longitudinal surveys in the United States (Morgan et al. 1974).

Emerging Theme Discussion Statements:

- TDS21: Data and modeling agencies should broaden their obligations to their client base by developing a capability to collect "what if . . ." data to supplement the descriptive "what is. . ." trip data as well as to reorient data to emphasize 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 databases with an appropriate information strategy to keep their customers well informed.
- TDS24: Data and modeling agencies must be credible to all so as to avoid disaffected groups developing their own data (plus networks, models, and forecasts). Rival allegiances to alternative sources of data are counterproductive.
- TDS25: Data and modeling agencies should become the recognized repository for agreed travel and network information.

Beyond Basic Travel Data: Other Information Output

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

Interpretative (Policy) Analysis

Stakeholders often perceive that in addition to collecting and preparing base travel data, data and modeling agencies have historically focused on model development at the expense of undertaking 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.

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 data and modeling agencies. This interpretative analysis is not a substitute for all client-interpretative activity. For example, local government often brings an added dimension of interpretation not observed at the center: the "center can provide the spanner, and local government transport planners can wield the spanner," notes one stakeholder.

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 Planning 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, outdated by the time they are available and never available in a form useful to the policy process.

Model estimation, calibration, and application is not well-understood by the majority of stakeholders. The historical lack of a demonstration of 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 embedding them within a decision support system. Such a system is designed to show how such models can provide information that may complement tabular data and also to provide another source of information to evaluate the many policy issues 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 proactive approach will ensure that the suite of model and data needs is kept up to date and remains policy-useful. Some feel that data and modeling agencies should move away from the very rigid and highly aggregate travel model system typically in place but with 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 (i.e., endogenous variables) in the model system as well as a much larger number of explanatory variables that have links to policy. Most metropolitan planning agencies (MPOs) are struggling with this transition, and very few have made the move.

Stakeholders highlighted a need for greater attention to modeling noncommuting travel activity, with a distinction between discretionary and nondiscretionary, noncommuting travel. Modeling urban freight activity was also emphasized as a globally neglected capability. Since externalities (e.g., traffic congestion, traffic noise, air quality, and global warming) now play a central role in transport and land use integration, the need to identify how travel behavior 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 that give new meaning to the evaluation of the big issues was cited many times. Armed with enriched advice from the state of the practice tools such as stated preference experiments 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 their abilities to comment on and/or refute statements made by community and other organizations often based on statistics of dubious interpretation.

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

The comments seem to reveal 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 fixes many land use and behavioral 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 (i.e., land use) and automobile choice models was emphasized. 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 address "what if . . ." scenario questions. This would allow for inspection of the wider impacts of decisions, without having expertise in all fields.

Emerging Theme Discussion Statements:

- TDS31: Data and modeling agencies should use the travel information base as a pre-emptive policy tool, not simply to 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 reorientation will be more policy-useful.

- TDS33: Data and modeling agencies should develop a strategic-level modeling capability in a proactive mode of policy relevance to assist the debate on the big strategic issues such as rail corridors, the future of urban consolidation vs. decentralization, road pricing, toll roads, etcetera.
- TDS34: A decision support system in which a model system is embedded is an essential tool of the data and modeling agencies and should be available to stakeholders and other clients through 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 geographically stratified, random sample travel survey of a large sample of households (Taylor et al. 1992a; USDOT 1996). In NSW, the 1971 Sydney survey was specialized 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[1] 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 . . ." behavioral responses. The survey data is processed and weighted up to the sampled population. Together with updated morning two-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 is estimated and calibrated to the morning peak baseline commuter traffic. In 1981, the modal split model was estimated at the individual traveler 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 produced two very strong views: 1) base travel data must be meaningful, long lasting, current, regular, and free of the political process and 2) the 10-year "big bang" survey strategy should be abandoned in favor of a rolling program of travel data collection, both passenger and freight, with a broadening out to accommodate "what is . . ." and "what if . . ." information.

There was a strong view that we need regular core data and a capability to undertake specialized surveys as required. "With all money often in the big 10-year survey, we are fund-strapped," noted one participant. Treasury is always concerned about the currency of data. Credibility requires currency at a level not available from 10-year surveys beyond the early years (up to 3 to 4 years). These issues are explored below. The issue of comparisons of travel activity over time was mentioned many times, with a strong desire to support both the creation of a mix of travel surveys, such as a household panel (e.g., Murakami and Watterson 1990), a firm panel, and a once-off single cross-section on a niche application. These would contain 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 be administered to a smaller sample, together with other data sources, such as a cordon survey, to obtain 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 three to five years or, alternatively, it could follow the lead of others surveys such as the VITAL

[1] A cordon survey typically involves distributing a reply post paid survey card to car users stopped at locations throughout the study area. The information sought includes origin and destination of trip, key routes, departure and arrival time, occupancy number, and a few socioeconomic characteristics such as age and gender.

survey in Melbourne, a continuous survey such that each year approximately 6,000 surveys are compiled, giving a rich database 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 strategies such as activity-based sampling and to weight the 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 a survey such as a rolling 12-month survey should 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 the timing of such a rolling survey program could be structured. The instrument for such a program would initially be a single cross-section, but such a program would 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 for a larger 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 post paid reply card requesting data on origin-destination (OD), mode, purpose, time of day, vehicle type, and travelling party composition is a cost-effective way of securing good spatial data. Doubts were expressed, however, 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:

- 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 (post paid reply card) seeking OD data, trip purpose, mode, trip times, etcetera, is the best way of collecting base spatial data for passenger and freight trips. When complemented by a smaller but regularly 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.

TABLE 2 Structure of a Rolling Survey Program

	High predictability	Low predictability
Stable area	LEAST OFTEN	
Changing area	MEDIUM FREQUENCY	MOST OFTEN

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? How reliable and credible is it? The most important considerations centered 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, all stakeholders see a transport agency as devoid of customer focus.

The discussion on the usefulness of various forms of information (including travel models) highlighted an important point, that the value of travel models in particular is poorly understood for reasons not directly attributed to a transport agency's performance. The issue is much wider and may be an indictment of the modeling community, which seems to have failed to communicate the value of its products. In part, this may be attributable to the poor packaging of model systems, a lack of good documentation of both a technical and lay nature, and the general absence of a series of courses able to handle the widely varying skills and needs of those who might benefit from the use of travel models. 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 1) technical documentation explaining the data, sampling, data collection process, response rates, weights, and models and assumptions of a methodological nature which are of current and historical importance; 2) promotional material indicating what is available and how to obtain information; and 3) short travel reports (perhaps 16–20 pages) with many graphs, with a small amount of interpretation, and prepared by an outsourced, professional publication agency.

Emerging Theme Discussion Statements:

- TDS51: Stakeholders who could have benefitted from the information collected by the transport agencies had little or 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 that specifically addresses the issue of information awareness and retrieval.
- TDS53: Data and modeling agencies should have a custodial role in providing advice to the government but also in assisting others to access information and models.

Institutional Context

Although we tried to avoid the issue of service delivery source, all stakeholders wanted to make a statement on this topic. It was recognized that any data and modeling agency, if constituted within a government department, has a requirement to satisfy the immediate and ongoing needs of the department first and then other government departments. The "closeness" to a department worried many stakeholders who expressed points about 1) access to core data regardless of the current political climate; 2) the extent to which a department might swamp the data and modeling agency with referrals for advice, possibly taking it away from what many believe should be the primary roles of collecting, preparing, and providing core travel data (including networks) and delivering it to all stakeholders and clients in a timely and efficient manner and of undertaking interpretative policy analysis and simple projections of broad stakeholder interest; and 3) the development and application of STIMS embedded in a spatial decision support system.

An important issue is the credibility of information and models. Stakeholders were keen to see some peer review mechanisms to ensure that the products of such a data and modeling agency were relevant, credible, well-documented, and available to all customers in a timely and efficient manner. A common view was that unit record data must be made available to the researchers and practitioners, a normal practice in some countries, notably in the United States (U.S. Bureau of Transportation Statistics 1993). Such an expensive and valuable resource needs to be utilized extensively in order to gain maximum benefit and to minimize duplication of effort. Household data is needed by many stakeholders "to do our own thing." Stakeholders need to access unit records to give flexibility in preparing problem specific data.

Emerging Theme Discussion Statements:

- TDS61: The data and modeling agency should release data at the unit record level 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 customer focus.
- TDS62: 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 but instead should produce useful output in a timely manner. A steering committee should review progress regularly.
- TDS64: An advisory committee should be comprised of 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 United States as part of the federal govern-

ment's ongoing Transport Model Improvement Program (USDOT 1996).

The stakeholders were unanimous in the view that a data and modeling agency must be proactive, 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.

CLIENT-BASED WORKSHOPS

Client-based workshops provide the second step, within which the accumulated contributions of the stakeholders were considered, debated, and enhanced to arrive at a participatory view of STIMS. The emphasis was on both content and context: what should be delivered, over what timeframe and resource commitments, and how might it be best institutionally and managerially delivered.

Essential to the process of the client workshops, preliminary preparation centered on 1) the discussion paper documented in the previous section, 2) the mechanisms for linking the outcomes required by stakeholders, and 3) the way in which the output of this participation process is 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 was invited to participate, including stakeholders themselves and representatives of a broader clientele of stakeholders (see table 3). Three workshops were conducted, and each 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 was delivered. Open discussion followed, with some direction to ensure that the three key areas of STIMS were adequately addressed: 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 and modeling strategy. The findings were reported back to the entire workshop, enabling final open discussion.

TABLE 3 Invited Participants in the Client Workshops

Organization type
Community groups
Transport associations
Transport research organizations
Consultants
NSW state government organizations
Academics
International
Interstate government organizations
Local government (NSW)
Other

The major outcome of the workshops can be divided into a reinforcement of the issues raised in the stakeholder interviews 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 closely accorded with the requirements of the broader client base; however, the workshops were essential in order to both confirm this agreement and to refine the issues raised. This reinforcement and clarification provided the confidence to move forward with the advice of 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 surveyed experts in 1995 to synthesize the international state of the art and the state of practice.

The 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 Behavior Research, TMIP conference

attendees, and members of the editorial advisory boards of the key journals in the field. The views were processed and summarized into key positions that were fed back to the panel in a second round to elicit further commentary. 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 the seven areas set out in the stakeholder interviews. A formal survey instrument was designed so that there was a common base of information sought. The experts were asked to comment on tools of design and analysis and also to provide views on how to use data and models to improve community commitment to the process and to emergent issues. Issues of response, communication consultation support, and information sharing were also covered.

The first round instrument was faxed out to participants in the last week of July of 1995. Of the 40 forms faxed out, 34 completed forms were returned. Analytic expert goals for the survey included:

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. What are the most vulnerable areas in analytic tools to date?

Application expert goals for the survey included:

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 they worked) would be most useful? At what level of detail?
4. How would you suggest making the data collection useful to yourself? To your organization?
5. What do you need data and models for most: consultation, design, strategic planning, consultant use, etcetera?

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-fertilization of the debate evolved. It was hoped that the outcome would then be more balanced between possibilities and practicalities.

Findings of the First Round of the Experts' Survey

The major findings from the first round survey are summarized in a number of tables and figures. One-third of the responses is from Australia, with the United States and the United Kingdom representing 38% of the sample (table 4). 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 is composed of consultants (table 5). Figures 2 and 3 summarize the responses to a series of policy questions in which we sought to identify the most important issues in the last five years (figure 2) and the most important issues over the next five years (figure 3). The issues that ought to receive the greatest attention in the next five years are summarized in table 6.

The results are very informative. Road maintenance has been the most important issue in the last five years and is still seen as 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 areas have been

TABLE 4 Country in Which Respondents Work

Country	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
United States	9	26.5
United Kingdom	4	11.8
Total	**34**	**100.0**

TABLE 5 Type of Organization Where Currently Employed

Type of Organization	Number of respondents	Percentage of respondents
University	18	53
Government	9	26
Consultant	7	21
Total	**34**	**100**

FIGURE 2 Priority Issues for the Last Five Years, in Decending Order

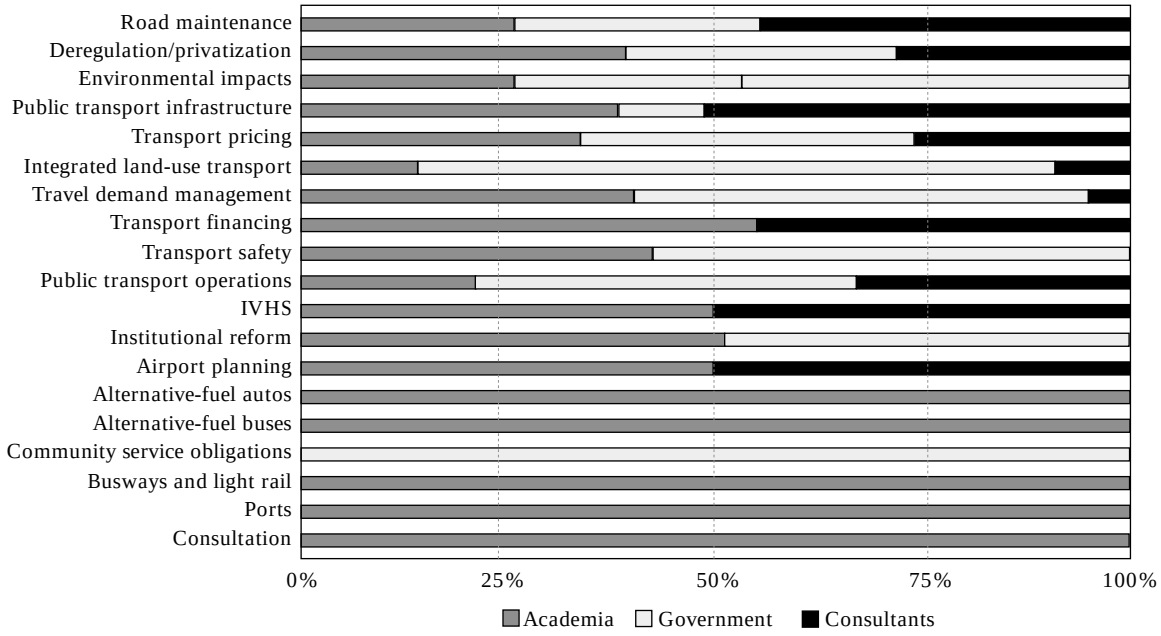
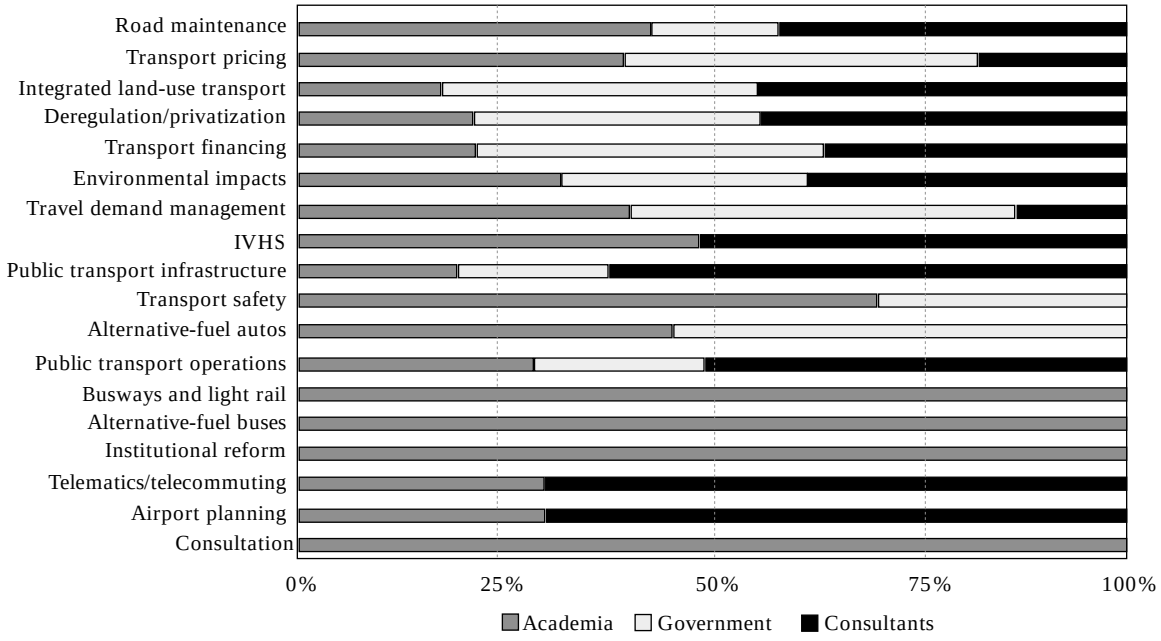


FIGURE 3 Priority Issues for the Next Five Years, in Decending Order



in the top six most important policy areas in the last five years and are likely to continue as high agenda items; the expert panel wishes 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 for receiving 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/privatization. Intelligent transport systems is interpreted similarly to environmental impact. It is also seen as best studied by international agencies, as are the broad areas of transport pricing and the

TABLE 6 Priority Shifts Over Time

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

environment. Telematics and telecommuting moved up substantially, reflecting a growing interest in this policy area.

The dominating role of road maintenance in the last and 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 multimodal approach to transport planning in the past with a stronger emphasis on land use implications. There is a view overall, however, that efforts in the past and in the next five years to improve public transport infrastructure are well established on the policy agenda; what is needed is more emphasis on pricing, land use, and demand management. The same argument applies to transport financing, currently given adequate treatment. Support for greater levels of consultation (as compared to the recent past) is also apparent, even though it is not thought to be as important as the economic issues. Data and modeling agencies are well positioned to contribute to the development of a modeling system that can assist in the debate on alternative land-use transport strategies with a number of alternative scenarios for pricing and travel demand management.

Table 6, showing priority shifts, is complemented by figure 4, which shows the changes in views over time in order of priorities rated by the experts. The themes summarized in the last column in table 6 are the areas where expected priorities are felt to be set too low, and those above where they were (or are expected to be) set too high. The views expressed towards various research and model development areas provide one aspect of the expert opinion consensus but do not clearly indicate the directions where choices are likely to be made. A series of weighted questions were included to

FIGURE 4 Priority Issues in Recent Past

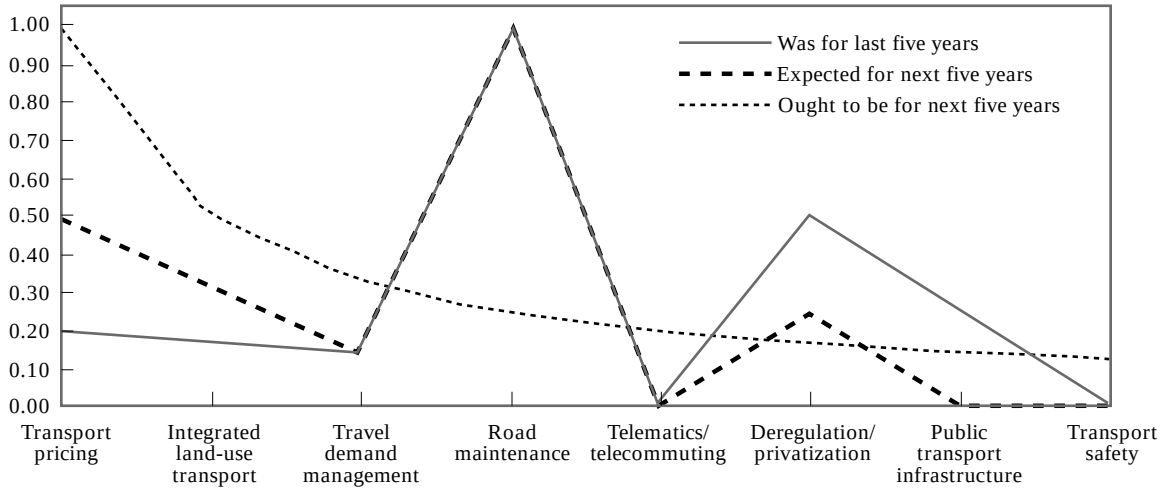
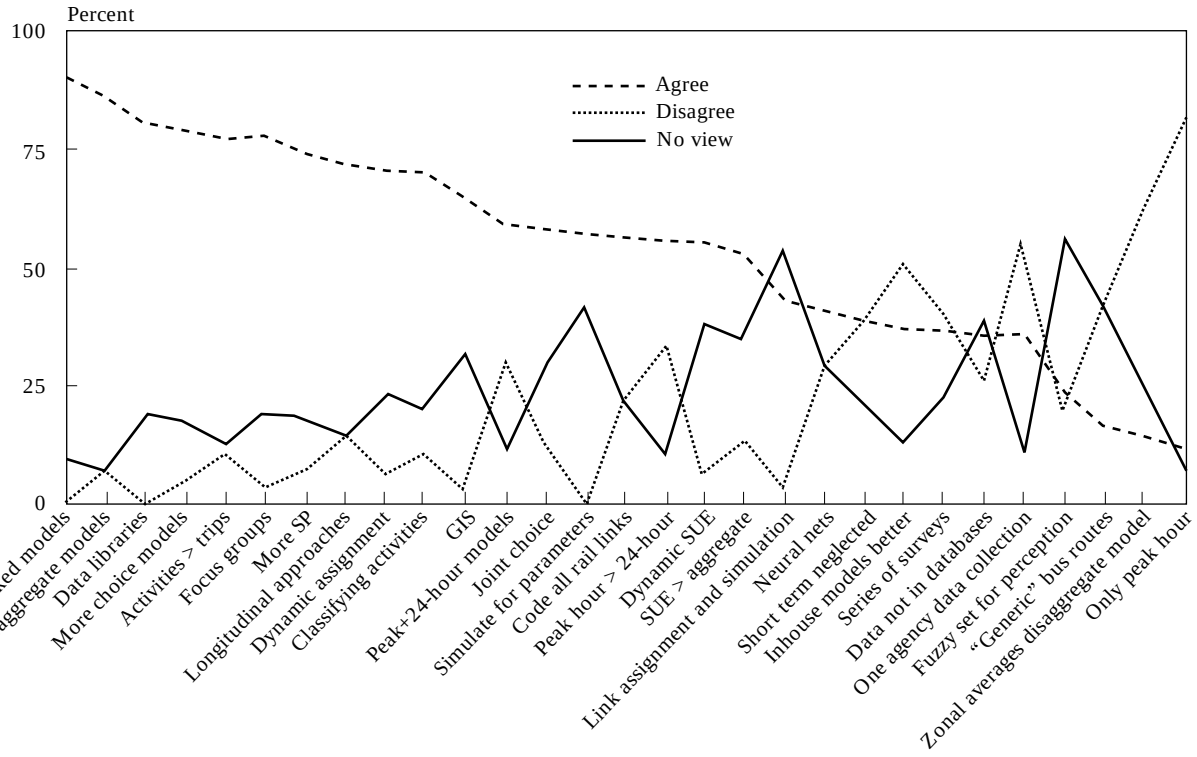


FIGURE 5 Priority Issues for the Near Future



probe further by eliciting opinions of this kind. Initially, it was felt that the survey had only mixed success, 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 be more closely linked, and there is a need for greater use of dissagregate choice models and an emphasis on activities rather than trips. Dynamic assignment and classifying activities into mandatory, flexible, and optional categories, as well as an increased use of longitudinal surveys, were also supported. The need for transport data libraries was strongly endorsed, with no recorded disagreements at all. The use of geographical information systems (GIS) for modeling and data management was widely recognized as important. A few respondents were in favor of using only peak hour models, coding only generic bus routes, and keeping data in a simplified format and outside data management systems.

Table 7 summarizes the experts' views on where the expertise lies in each respondent's own country in 20 skill areas. Overall, the perceived expertise in most skill areas is currently seen to lie with consultants and universities, in contrast to any level of government. Highway networks stand out as having a competitive edge in expertise within the state government sector. Table 7 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 data 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 has virtually equal billing with universities and consultants in policy analysis, with state and local government falling behind in this area.

Overall, the views support the proposed emphasis of a data and modeling agency managing the survey and data aspects of STIMS and 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

TABLE 7 Expertise of Different Organizations[1]

Skill area	Federal government	State government	Local government	Universities	Subsidized research organizations	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)

[1] Figures are mean ratings, with standard deviation in brackets.
1 = very good, 20 = very poor.

land-use transport and transport pricing, probably reflecting concern over the increasing difficulties in financing new infrastructure. They also noted the necessity of having a sound integrated planning framework to maintain control as more partnerships and private financing are used.

Table 8 summarizes 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 organizations adds another dimension. Problems do occur outside of the government sector, most notably in the areas of documentation, expense, organization, and property rights.

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 behavior. 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 noncommuting, commuting, household activities, firm activities, and freight/commodity movements.

The research areas have a mean rating varying

TABLE 8 Common Frustrations in Accessing Data from Various Agencies (in order of frequency of response)

Government	Private data agencies	Universities
Delays in access	Expense	Lack of documentation
Confidentiality restrictions	Data too specialized	Disorganized approach
Poor staff response	Poor documentation	Inappropriate data
Knowledge of what is available		Uncertain property rights
Expense		

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. Stakeholders and participants in the workshops referred to all of these research areas on many occasions. The correspondence between the three consultation instruments is most encouraging. The next 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 of 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 behavior.

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, as supported by stated preference data, enabling the analyst to enrich the revealed preference data in contexts not readily observed in the market but possibly 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. They were also asked to indicate whether they thought that implementation is feasible today for the approach in each statement and whether they have implemented any of the policies underlying each statement (tables 9, 10, and 11). Agreement with each statement varied from 11 to 90%. The most agreed on statement was "traffic simulation and travel demand models should be linked" (statement 8). The least agreed on statement was "a city only needs a peak hour model." Once again we see 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 with in respect to 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 9 confirms the support from analytical and applications experts for an approach to modeling that is flexible in the level of disaggregation of data and model estimation, that spawns a widening set of behavioral models to reflect the impacts of peak spreading and noncommuting activity, and that promotes the ideas of longitudinal data, stated preference methods, and activity-based approaches to modeling travel behavior.

In evaluating the feasibility of translating state of the art ideals into practice, 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 highlighted in all dimensions of the consultation process, the level of feasibility as indicated by the expert panelists 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 true challenge. The support of the consultation participants is essentially in the area of activity diaries with more conventional behavioral model specifications.

Figure 6 summarizes the implementation profile of the participants with respect to the items in the statements. There is a relatively high incidence on nonimplementation (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 specialized researchers not actively undertaking research in many of the areas, though they do have an appreciation of their relevance.

TABLE 9 Experts' Survey Results: Where Should the State-of-Practice Lie?

Statement	Agree	Disagree	No view
Activity data and models more useful than trip-based approaches	77%	10%	13%
Longitudinal data and models should replace static approaches	72%	14%	14%
Focus groups useful to understand household decisionmaking	77%	3%	20%
Should be greater use of SP questions in surveys	74%	7%	19%
GIS should be used for database management and model integration	65%	3%	32%
Data should be held in simple forms rather than databases	35%	26%	39%
Stochastic simulation should replace deterministic aggregate extrapolation	53%	13%	34%
Traffic simulation and travel demand models should be linked	90%	0%	10%
The use of disaggregate choice models should be expanded	79%	4%	17%
Simulations should be used to develop stable travel model parameters	57%	0%	43%
Joint choice decisions should be modeled 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 24-hour 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 24-hour 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 a behaviorally useful way to recognize 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%	0%	19%
Core travel data for an urban area should be collected by one agency	35%	55%	10%
Short and medium term forecasting is often neglected in favor of long term forecasting	39%	39%	22%
Travel surveys should evolve from a single large survey to a series of smaller integrated surveys usually with a single goal	37%	40%	23%

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 the contents in order to establish any variation 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 the first round.

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 the support of 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 on 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

TABLE 10 Experts' Survey Results: Is Implementation Feasible Today?

Statement	Agree	Disagree
Activity data and models more useful than trip-based approaches	76%	24%
Longitudinal data and models should replace static approaches	92%	8%
Focus groups useful to understand household decisionmaking	100%	0%
Should be greater use of SP questions in surveys	96%	4%
GIS should be used for database management and model integration	96%	4%
Data should be held in simple forms rather than databases	100%	0%
Stochastic simulation should replace deterministic aggregate extrapolation	94%	6%
Traffic simulation and travel demand models should be linked	91%	9%
The use of disaggregate choice models should be expanded	100%	0%
Simulations should be used to develop stable travel model parameters	94%	6%
Joint choice decisions should be modeled 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 24-hour and peak hour model	100%	0%
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 24-hour models	100%	0%
Traffic assignment models should be linked with traffic simulation	100%	0%
Every rail line should be coded on the network	100%	0%
Bus routes should be represented as "generic" routes to reflect a corridor	100%	0%
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 a behaviorally useful way to recognize possible variability	100%	0%

FIGURE 6 Priority Shifts Over Time

Arranged by leading indicator with 1 as the highest priority

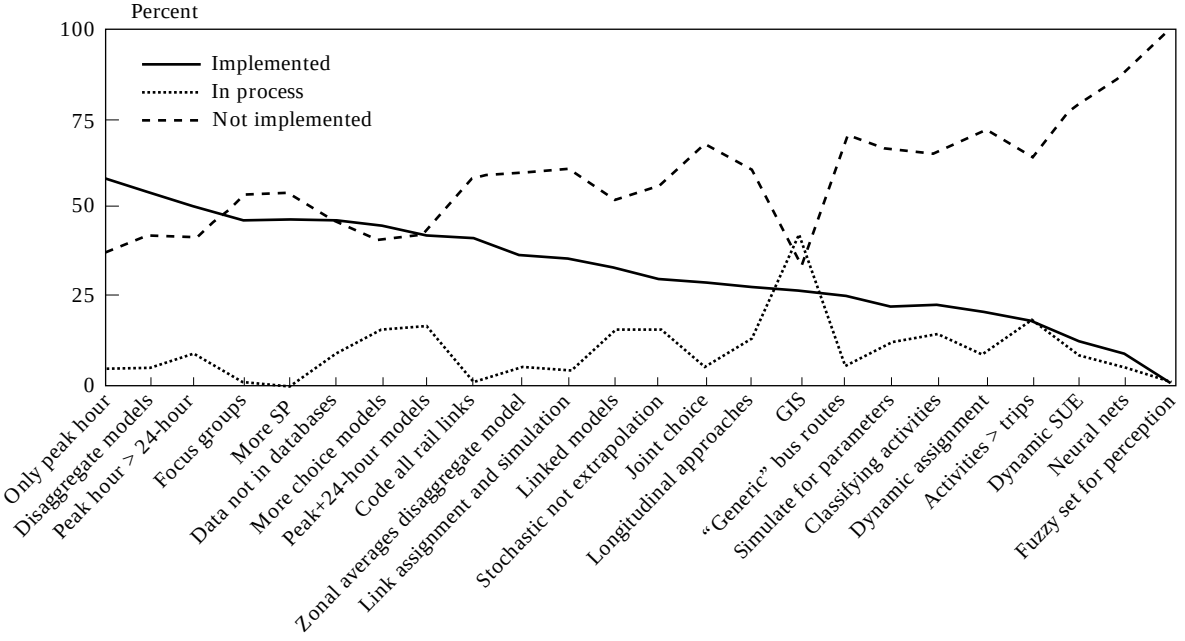


TABLE 11 Experts' Survey Results: Have You Implemented These Policies?

Statement	Implemented	In process of implementation	Not implemented
Activity data and models more useful than trip-based approaches	18%	18%	64%
Longitudinal data and models should replace static approaches	27%	12%	61%
Focus groups useful to understand household decisionmaking	46%	0%	54%
Should be greater use of SP questions in surveys	46%	0%	54%
GIS should be used for database management and model integration	26%	41%	33%
Data should be held in simple forms rather than databases	46%	8%	46%
Stochastic simulation should replace deterministic aggregate extrapolation	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 parameters	22%	11%	67%
Joint choice decisions should be modeled in preference to sequential models for many travel choices	28%	4%	68%
A city only needs a peak hour model	8%	4%	38%
A city needs both a 24-hour 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 24-hour 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%	0%	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	0%	0%	100%
Use of neural networks (or similar) should be expanded	8%	4%	88%
Classifying activities into mandatory, flexible, and optional is a behaviorally useful way to recognize possible variability	22%	13%	65%

utilizing 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 were finalized at the end of 1999, with a focus on car ownership and driving license holdings, as well as trip frequency, trip destination, and mode choice for the journey to work tours. Ongoing implementation of a nonwork 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 key stakeholders.

Good practice in data collection supports an ongoing survey process that guarantees the timeliness and representativity 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 (e.g., every five 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 (e.g., 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 recognize 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 it 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 in order to at least recover the value-added element.

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