

# Future directions in urban transport data collection

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## Abstract:

The paper describes the output of a research project aimed at developing a framework for future urban transport data collection in Melbourne. It is suggested that a new survey program covering person and freight transport demand for the Melbourne metropolitan area is essential for credible future transport planning. The paper describes a preferred direction for the survey program, based on a rolling sequence of surveys, using stratified sampling, and running on a five year cycle. The recommended technology for this program is a combination of telephone interviews and self-administered questionnaires (with travel and activity diaries), providing survey instruments capable of repeated use over the required time frame.

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## **Introduction**

Information about travel behaviour and transport system operations is a necessary input to transport policy, planning and design processes. However, such information is difficult and expensive to collect and keep current, and as a result is collected infrequently, especially for urban areas. In the case of Melbourne, a major household interview survey was conducted in 1964, supplemented by a small 'follow-up' survey in 1972, and another detailed travel survey was conducted in 1978-79. This information is now out of date, and in any case significant changes have occurred in recent years in many of the factors which affect travel demand. For this reason, the Ministry of Transport and the Authorities within the Transport portfolio considered that there was a need for another major survey or surveys to collect data to provide the information necessary for policy, planning and other activities in the 1990s.

Before proceeding with such surveys a research program was undertaken, with the aim of reviewing the broader issues defining the context within which transport surveys should be conducted, particularly in view of changing needs for and uses of transport information, developments in knowledge and understanding of travel behaviour, and emerging opportunities for data collection and information management. The Melbourne Travel Survey Research Project (MISRP) was undertaken by the authors during 1988-89. The findings of the project have been documented in detail in the projects reports (Taylor et al, 1989 a,b). A review of its findings concerning survey design and data collection are presented in Taylor et al (1990). This paper only briefly reviews these aspects, but discusses in more detail practical aspects concerning survey organisation and on-going data collection and information management requirements.

## **Historical Context**

Since the advent of large scale urban transport planning and modelling exercises in the late 1950s, information about travel patterns and the factors affecting it have been a necessary input. However, the needs and characteristics of the data collected and the uses to which it has been put have varied over the years (Hartgen, 1990).

The 1960s featured centralised area-wide surveys. They were mainly management driven and focused on multi-purpose information gathering and description of travel patterns, for use in system-wide travel forecasting models. Sample sizes were high (of the order of 5000-20 000). These benchmark surveys provided a much needed quantification of transport demand and supply, and were direct inputs to the planning of substantial urban road and public transport infrastructure investment programs of the 1960s. They were, however, costly and required considerable resources of personnel, time and effort. An important legacy of these surveys was that they provided very useful information about many aspects of urban travel and land use, and as a result the data was used by many organisations other than those concerned with transport planning.

The 1970s saw greater emphasis on environmental and energy related issues, and recognition of the mobility needs of the handicapped. Urban transport surveys were targeted at specific markets, especially public transport markets, and towards assessing the needs of the elderly and physically disabled. The population focus was typically smaller both geographically and demographically than had been the case in the 1960s. Sample sizes were of the order of 2000-5000 and were often choice based.

In the 1980s, surveys were even leaner and meaner and their focus shifted. They tended to concentrate on individual highway projects or corridor plans, with the main purpose being to provide current information for project decision making. Sample sizes were of the order of 500 telephone surveys or 1000 postcard surveys. Information was put directly into the computer and used for project and impact description. Models developed from this data were rare.

Hartgen (1990) went on from this general historical trend to predict the survey types of the 1990s. He suggests that the lack of a compelling case for resurveying overall travel patterns in urban areas will increase the pressure for fast, relevant, cheap and politically useful surveys. Surveys will be faster, cheaper, private sector, one issue, and site based. The priorities will be for information to support policy on economic issues as competition for growth increases. The likely growth in private sector roles in transport issues will change the client base and tend to increase the need for financial as well as economic analysis. He suggests that the less coordinated smaller surveys may become the tool of particular private organisations and lobby groups, and as a result the transport planning organisations may need to have some data to try and determine if the data and findings of the smaller surveys are well founded.

In this context it is worth considering the proposals for the next round of transport surveys being planned for London (Focas and Capell, 1990). A major survey is planned for 1991, following up the studies undertaken in 1981, 1971 and 1962. It is to be run in conjunction with the ten year population census. The establishment of the project is a combined initiative of Department of Transport and London boroughs, in the absence of an overall planning body for London. The 1991 survey has the following features:

- the household interview survey will incorporate light goods and will cover two per cent of the population,
- a hotel and institution survey will be run,
- all modes will be included in the outer cordon,
- goods vehicles will be surveyed,
- road and interview surveys will be carried out as comparative sources of information, and
- roadside count data will be used for expansion

## **Research method**

As noted previously, the essential task of MTSRP was to review the whole field of data and information in relation to urban transport planning. This included three basic phases:

- review of past uses of travel information,
- current and anticipated needs for travel information,
- examination of current and emerging travel survey methods, and
- proposals regarding new travel survey information and its management

The research included a comprehensive literature survey, a questionnaire survey of transport authorities and professionals in Australia and overseas, and a one-day workshop involving invited experts, held in Melbourne. The research approach and findings are described elsewhere (Taylor et al, 1989a,b), and some of the key findings are reviewed, as they relate to the areas of information requirements and survey methodology.

### Information requirements

Information on travel demand and associated socio-economic and land use factors is a necessary input to policy formulation and operational and investment decision making by transport authorities (in Victoria, the Ministry of Transport and the two transport authorities, the Public Transport Corporation and the Roads Corporation). It is also of value to secondary clients, such as other government departments, local government, transport researchers, and consultants. The basic task of a transport information system is therefore to provide comprehensive travel databases and interpretations to its clients. The areas of application identified in the course of the project as being relevant to clients were described in Taylor et al (1989a,b).

Given these applications, it is possible to define information resource areas and to identify specific data items that provide the detailed information likely to be required for each. Table 1 lists these areas and specific data items. The set of information resource areas presented in Table 1 is composed of a group of land use-related variables, which largely define the purpose of travel, as well as freight movements and people's attitudes to travel and the transport system.

### Survey methodology

The traditional means for collecting travel information has been to select a sample of households representing the metropolitan area and then survey these households at their residences. Surveys were usually undertaken using face-to-face interviews, referred to as a Household Interview Survey (HIS) (In this paper a narrow definition is applied to HIS. This refers to personal interviews conducted face-to-face in the respondents' homes, i.e. the traditional form of interview survey in transport planning.) The MTSRP project identified six problems with the HIS, which have particular importance given the list of data items identified in Table 1:

- the HIS method provides little reliable information about person travel that does not have the residence as one trip-end, unless it is supplemented by some other means of data collection (e.g. travel diaries). Non-home-based trips appear to be increasingly important as a proportion of total metropolitan travel;

**Table 1: Travel Survey Information Resource Areas and Some Specific Data Items**

- 1 Information on trip generation and parking rates for major land uses (e.g residential, commercial, retail, industry, services, entertainment, cultural and recreational).
- 2 For each of the major land uses, travel information (including origins and destinations and transport modes) relating to aspects such as inter-related land uses and travel purposes:

<i>Information Resource Area</i>	<i>Specific Data Items</i>
home based trips	trip rates by mode and purpose, off-peak vs peak period travel, linkages to other activities
commercial	trip rates by mode, off-peak vs peak period travel, linkages to other activities
industry	commercial vehicle trip generation, off-peak vs peak period travel, linkages to other activities.
retail	other activities undertaken whilst shopping, multi-purpose trips to/from retail
entertainment, cultural	multi-purpose travel, linkages to other activities.
work	multi-purpose travel to/from work, trips made while at work, multi-modal travel to/from work, vehicle occupancy for travel to/from work
recreational	multi-purpose travel, off peak vs. peak period travel, linkages to other activities
freight	origins and destinations, mode used, frequency, types of commodities carried, volume or amount
attitudes	choice of mode, workplace or retail centre, importance of travel and access in residential location choice, percentage of income spent on travel, reasons for level of car ownership

**Table 2: Ability of Survey Instruments to Efficiently Gather Specific Data Items**

Data Item	HIS	IIS	SAQ	IIS
<i>home based trips</i>				
to work	■	○	■	■
to retail	■	○	■	■
to school/education	■	○	■	■
other purposes	■	○	■	■
<i>commercial</i>				
trip rates by mode	○	○	■ <sup>1</sup>	
off-peak vs. peak period travel		○	■ <sup>1</sup>	
linkages to other activities		○	○ <sup>1</sup>	
<i>industry</i>				
commercial vehicle trip generation		○	■ <sup>1</sup>	
off-peak vs. peak period travel		○	■ <sup>1</sup>	
linkages to other activities		○	○ <sup>1</sup>	
<i>retail</i>				
other activities undertaken whilst shopping	○		○	■
multi-purpose trips to/from retail			○	■
<i>entertainment/cultural</i>				
multi-purpose travel	○	○	■	■
linkages to other activities	○	○	■	■
<i>work</i>				
multi-purpose travel to/from work	○	○	■	■
trips made while at work		○	■	■
multi-modal travel to/from work	■	○	■	■
vehicle occupancy for travel to/from work	■	○	■	○
<i>recreational</i>				
multi-purpose travel	■	○	○	■
off peak vs. peak period travel	○		○	■
linkages to other activities			○	■
<i>freight</i>				
origins and destinations		○	■ <sup>1</sup>	
mode used		○	■ <sup>1</sup>	
frequency			■ <sup>1</sup>	
types of commodities carried			■ <sup>1</sup>	
volume or amount			■ <sup>1</sup>	
<i>attitudes</i>				
choice of mode	○	■	○	■
choice of workplace or retail centre		■		■
importance of travel/access in residential location choice	■	■	○	■
percentage of income spent on travel	■	■	■	■
reasons for level of car ownership	○	■	○	■

HIS = household interview survey, TIS = telephone interview survey ■ = useful  
 SAQ = self-administered questionnaire, IIS = interactive interview survey ○ = limited use  
 <blank> = little if any use

1 assuming use of a set of questionnaires each designed for specific data resource areas

- the HIS is not even particularly reliable for revealing the extent of home-based trips (e.g. short distance trips, walking and cycling trips, and day-to-day variations can be poorly treated);
- it is an inefficient means of collecting detailed data on attitudes to transport;
- it provides little if any information on freight movements;
- it provides little if any information on the trip generation characteristics of non-residential land uses, and
- it is an expensive and cumbersome survey instrument

Consequently, it was concluded that other survey methods may be needed to replace or complement the HIS. Other available methods include:

- *Telephone interview surveys* (TIS), which are now the principal survey instrument used in market research, and which have a powerful support technology already in place,
- *Self-administered questionnaire surveys* (SAQ), of which the KONTIV design is well-established survey instrument for collecting travel data. KONTIV provides methods to overcome the biases from non-response that are sometimes found in SAQ surveys, and
- *Interactive interviewing surveys* (IIS), which are proven instruments for the collection of detailed information on people's travel habits and attitudes.

These survey techniques are reviewed in Taylor et al (1989a) and Ampt, Richardson and Brog (1985). Table 2 provides an indication of the relative suitability of each of these methods for the collection of the specific data items given in Table 1.

A travel survey must also collect demographic data, to allow the sampled travel data to be transformed (through expansion procedures such as those described by Heathcote (1984)) to represent the total travel demand in the study area. All of the survey methods cited above can be used to collect demographic and socio-economic data, although the IIS method would not be suitable for use on a large scale.

The basic information sought under the data items should include indications of the frequency of participation in different trip making categories. This can be achieved by the use of 'n-day' travel and activity diaries, where *n* is at least two, and the days for trip recording are spread over the seven days of the week, i.e. not just the 'working week'. Further, questions asking individuals about the last time that they used various modes of transport will provide valuable information about the propensity of the population to use the full range of available transport modes.

## **Future directions**

MTSRP led to three major conclusions about the need for a new direction in future urban transport surveys and the administration of the resulting information base. Firstly, the existing large scale travel databases for Melbourne are now obsolete and should not be taken as reliable indications of travel demand in the Melbourne metropolitan area. There is a need for a new large scale database to guide transport planning and policy in the 1990s. The lack of up-to-date information has served to make transport planning

investigations (e.g. growth corridor studies) more difficult, and as a consequence will limit the quality of decision making in these instances. Secondly, there is a need for longitudinal data surveys to provide updates on changes in travel behaviour and to provide monitoring information for transport systems design and operation. Thirdly, there is a need to ensure the ongoing availability of travel information in forms useful for direct application in decision making, and to maintain the expertise needed for the collection, interpretation and dissemination of that information.

Based upon these conclusions, it is possible to define and describe a preferred future direction for travel surveys in urban areas in general, and Melbourne in particular. The elements of such a program are outlined below

### Systems approach

The traditional transport survey methodology is based upon a single 'cross-sectional' survey, emphasising the mechanics for designing and executing the survey, and analysing the data. This accommodates the development of expertise in the conduct of the survey, but does not allow for the ongoing interrogation of the database assembled after the survey. This interrogation was identified in MTSRP as a primary requirement of a modern travel information system. A revised methodology is required to encompass:

- the new phases of assembly, management and interrogation of the database,
- routine reporting of information extracts from the database, and
- explicit inclusion of updating and supplementary surveys as an integral part of the travel information and surveying process

In essence, the revised process should provide an integrated system for the collection, interpretation, analysis and dissemination of travel information in an ongoing framework. Taylor et al (1990) provides a detailed description of such a system.

### Transport Information Unit

The approach described above is based on the following tenets: an on-going program of longitudinal surveys to provide relevant travel information for use by planners and decision makers; ongoing maintenance of the transport database; preservation of knowledge and expertise about the transport database, its structure and contents; and the ability to provide for the needs of the users of travel information as a routine task.

These tasks necessitate the establishment and funding of a core unit to take responsibility for them. One of the findings from the MTSRP questionnaire survey was that the prime reason for the relatively low level of use of previous data sets was the lack of backup interpretation and archival services.

The concept of a core unit is not new. In fact, many transport agencies have had the elements of such a unit at various times, but without always recognising the need to explicitly support these activities. Consequently the database management operations have been fragmented and disjointed. Knowledge and expertise have been gained and then lost through staff transfers and attrition, so that the full value of the information gained from previous surveys has not been realised. This would not be important if the

use of the transport data was still primarily for the development of models, as modelling tends to be a long term activity and time can be found to restore lost knowledge. However, transport data are now sought for direct applications in policy determination and in resolving planning issues. Data can only be of value in these circumstances if relevant data items can be quickly and reliably extracted and reported. Hence the need for a unit that can operate and maintain an information management system capable of providing required data on request.

The Transport Information Unit would thus develop and maintain the travel data information system, and disseminate information from it. Further responsibilities in the use of the data, such as model development, research and transport network analysis and impact assessment could also be given to the Unit.

### New data requirements

The research indicated five major overall needs which require quantitative travel survey data, as follows:

- quantify traffic flows over the entire area, and explain their significance and composition;
- respond to the emergent need for policies for overall travel demand management, including pricing and traffic restraint;
- identify and estimate the impacts on groups which would be affected, and how they would react, to changes in activity pattern, accessibility or transport provision;
- monitor freight and associated developments and movements, and
- assess the impacts of land use developments at both micro and macro scales, and over time.

In addition, the research suggested that information to help tackle the following issues within the currency of the data collected in a new Melbourne travel survey are needed, given impending changes in:

- legislative, institutional or regulatory constraints;
- population structure (e.g. travel needs of the aged);
- economic conditions (leisure, tourism, service sector, etc.), and
- transport and communications technology (e.g. communications-transport interactions, on-board vehicle navigation and control systems).

The conventional interest of metropolitan travel surveys has been on 'normal' personal travel, i.e. travel involving typical person movements, such as weekday travel. The significant changes occurring in life style, household composition and employment characteristics (see Ogden and Taylor, 1985) mean that care must be taken not to restrict surveys of travel demand within artificial limits that may no longer provide proper bounds on travel. Future travel surveys should consider travel behaviour and its variations over the full weekly cycle. Proper account must also be taken of non-home-based travel, which is observed to be increasing absolutely and as a proportion of total trip making (Norris and Shunk, 1986). Further, the new importance of tourism and tourist-recreation-related activities as part of the economic and social framework of our cities requires knowledge about the role of special activity centres (retail, sporting,

cultural, recreational, etc.) in shaping the patterns of travel demand, and their roles in determining the limits of performance of our transport systems. It is not unreasonable to suggest that proper planning for the logistics of the 1996 Olympic Games would certainly require full knowledge of the present patterns of travel demand and the capacity of the transport network to cope with these base levels of demand and additional loads generated by special events.

A further important outcome of MTSRP was the demonstrated strong need for information on freight movements. Freight information is not amenable to collection through surveys directed at person travel only, suggesting that separate surveys of freight movements should be included in the new travel survey. In similar fashion, surveys of attitudes towards the supply and use of transport facilities are best done using methods such as interactive interviewing. The range of special-purpose and marketing surveys presently undertaken by The Met could also be integrated into the survey program.

### Study area

The question of the extent and definition of the study area for a new travel survey is important. Although other definitions are possible (e.g. commuting areas) it was recommended that the study area for the travel survey is best limited to the region which will form the contiguous urbanised area of metropolitan Melbourne in the 1990s, and that will be served by public transport services operated by The Met. It is reasonably easy to define the area of urban public transport service provision, and a little more difficult to define the area of the urban road network. Nevertheless, the combination of contiguous urban-type land uses and zoning and the Melbourne's area-wide traffic control system (SCRAM) (plus future extensions) provides an indication of this area.

There is also need to coordinate the study area definition with that used by the Australian Bureau of Statistics (ABS) for its Census of Population and Housing, which comprises the large scale demographic database that is most suitable for expansions of travel survey sample data to describe the behaviour of the urban population. The Melbourne Statistical District (MSD) is thus a useful definition of the likely study area that meets all of the above criteria. Liaison with ABS is necessary on this definition, given impending changes to the definition of the MSD for the 1991 census and beyond.

### Preferred techniques

The preferred system involves a set of survey techniques and standard survey instruments for data collection, computer hardware and software for data entry, editing, analysis and reporting, and systems for the maintenance and distribution of the travel database.

A combination of telephone interview surveys and self-administered questionnaires (of the KONIV type) is recommended for the collection of travel demand data, in a rolling program of 'cross-sectional' surveys. The rolling program of repeated cross-sectional surveys is seen as preferable to a single large scale survey as a means of achieving a cost-efficient and cost-effective travel data collection program.

whilst achieving the stated objectives of providing a useful contemporary cross-sectional data set supplemented by a series of longitudinal surveys (see below).

Sampling issues are discussed below. At this stage, however, it is sufficient to indicate that the recommended system is based on a stratified sampling scheme. Stratification in each annual repeat of the survey could stem from a focus on a different traveller group in each year (e.g. public transport users, fringe area households, the elderly, etc). The initial survey of this program would need to yield a larger sample size than the subsequent surveys, to provide a firm basis for the survey program. The initial survey would, however, be of significantly smaller size than that required for a single cross-sectional survey alone. The rolling survey program would provide the equivalent of the single cross-sectional survey over a five year cycle. Its advantages, however, would include the rapid release of the earliest data collected, and a means for monitoring trends in travel behaviour.

The mixture of telephone interview surveys (TIS) and self-administered questionnaire (SAQ) surveys is recommended as providing an efficient means for screening interviews (via telephone) from which households and organisations could be selected for participation in KONTIV-type self-administered questionnaires, which include travel diaries to be completed by individuals from the household or organisation. For households, the diaries should extend over a continuous period of at least two days, selected within the seven days of the week. For other organisations, e.g. businesses, hotels, institutions etc., the diaries might need to be restricted to a single day. The combination of TIS and SAQ surveys is capable of application to both residential and non-residential sampling frames, which is a significant advantage over HIS methods.

TIS provide a comprehensive, quick and efficient means for area-based sampling, establishing contacts, and collecting preliminary data that may also be used to verify the SAQ results. There are well-established techniques and hardware for TIS in the market research area (Beed and Stimson, 1985). The TIS is, however, unsuitable as a complete replacement for HIS methods, due to the complexity of the travel survey questionnaires and the time required to complete them. The SAQ, particularly using a KONTIV-type method, provides a viable alternative for large scale surveys when used in conjunction with the screening TIS. The SAQ also provides a permanent survey instrument that may be used in repeated surveys, is always available for study and use, and thus may be used to provide firm connections between the repeated cross-sectional surveys. A range of SAQs would be required for household, industrial, retail, tourist and freight applications. The Transport Information Unit would be responsible for the SAQ instrument.

TIS provide for direct entry of data into computers, thus offering significant advantages in data coding and editing and consequent productivity gains. Similar methods of direct entry of data from SAQs and diaries should be considered.

The system should utilise a modern general-purpose Geographic Information Systems (GIS) software package. GIS offer database manipulation and interrogation facilities within a geographic framework, and are capable of integrating different data sets that share a particular geographic region as a basis (e.g. ABS population data and sample travel data). They allow for the establishment of flexible zoning systems that permit the automatic translation of point data (e.g. from a given location such as a household residence) into any selected zoning system (e.g. LGA, postcode, transport zone, Census Collector District). The features that a GIS should possess include:

- use of a common, established command language that is known on a range of computer systems including PCs. The Standard Query Language (SQL) is a good example, and
- existence of versions of the software that run on a variety of mainframe computers, workstations and PCs, to allow the easy transfer of a database between computer systems. This maximises the availability of the database to users and analysts. The use of compact disk-read only memory (CD-ROM) technology for database storage is a powerful means for data dissemination, that is already in use in areas related to transport surveys.

The computer hardware needs for data entry, editing and analysis, database assembly and information dissemination can be met in a variety of ways, given the present state of information technology. A set of personal computers can be used for data entry and editing, and information display. A more powerful workstation or mainframe computer should be used for database assembly and maintenance. The use of a GIS such as ARC/INFO is recommended as there are versions of this software for all of these hardware systems. Peripherals including CD-ROM, hardcopy output devices (minimum requirement laser printer or pen plotter) and optical character reading (OCR) should be included.

#### Operating mode

As noted above, a three-level approach to data collection is proposed, involving the use of telephone interview surveys, self-administered questionnaires and interactive interviewing surveys. These approaches are described below.

*Telephone surveys:* The use of telephone surveys for collecting travel data is new in Australia. The technique has, however, been used in transport surveys elsewhere, particularly in North America. Telephone surveys are common in non-transport data collection, and many market surveys are now carried out using this means. Traditional home interview surveys (HIS) are expensive and the process of visiting a household in the hope that people are home is time consuming. The use of telephone surveys in transport thus provides a method of reducing the cost of data collection.

However, telephone surveys cannot provide all the information at the level of detail required in a transport survey (see Table 2). The telephone interview should therefore need to be part of a series of surveys. It could provide the first point of contact. Follow-up reply-paid questionnaire and diary surveys (e.g. KONTIV) would make up the remainder of the data collection process. The telephone contact would include some introductory questions relating to demographic characteristics and mode choice characteristics. These questions would form the basis for stratification for the follow-up surveys.

*Sampling unit:* The sampling unit can be either the household or the individual. The telephone survey lends itself to the individual but the household is possibly a better basic unit for the travel survey. The definition of a household needs to be clear as some telephone lines service more than one household.

*Sampling frame:* The sampling frame in a telephone survey is those households with access to a telephone. In 1984 this was approximately 91 per cent of households in Melbourne (Richardson, 1984). The nine per cent without access was not a typical group and includes an over-representation of the young, old, poor, tourists, single bedroom households and itinerant workers. Further, certain members of the household are known to be unresponsive to a telephone call (e.g. elderly males), while about seven per cent of households have two or more telephone lines. These sampling problems must be recognised and corrections made to ensure the final data set is reasonably representative of the total population.

*Stratification:* Random samples of households may not give sufficient coverage to all aspects of travel that are of interest. It is therefore necessary to stratify the sample in some manner. The 1978-79 survey in Melbourne was stratified by local government area to ensure a sample representative of the spatial character of transport. The proposed survey should also be stratified in this manner. The major advantage of a spatial stratification is that the basic information for stratification is always available. A further stratification that could be carried out is to use mode of travel. Stratification on this basis would ensure that a reasonable sample of all mode users are included. However, information on the mode of use of particular members of the household is not known until the households have been contacted; this is one reason for using a telephone as the first point of contact, i.e. to provide a basis for such stratification.

*Sample size:* The process of determining final sample sizes reflects a trade-off made between competing interests within the overall survey framework (Taylor and Young, 1988). A pilot study should aid in providing an indication of the appropriate mix of activities and the resulting sample size.

Several approaches can be made to determine sample sizes. If the trip rate is to be used as a criterion, and if it were necessary to determine the trip rate to within  $\pm 5$  per cent at the 95 per cent confidence level, then a sample of about 18 000 households would be required. If the accuracy level were  $\pm 20$  per cent or  $\pm 50$  per cent then samples of 5000 and 1000 households respectively would suffice. Further, if the origin-destination matrix were the criterion for determining the sample size and if it were required to determine the trip proportion of about five per cent from any zone to within  $\pm 5$  per cent at the 95 per cent confidence level then 3500 households would be required in each zone. Lower levels of accuracy such as  $\pm 20$  per cent and  $\pm 50$  per cent would require 250 and 40 households respectively.

The total sample size chosen to illustrate the approaches discussed in this paper is 18 000 households. This is approximately equivalent to determining a 10 per cent proportion of trips to within  $\pm 10$  per cent with 95 per cent confidence.

*Location of households:* There are many methods of obtaining the telephone numbers of the possible respondents. The most common is random dialling. Telecom will provide information on area codes and the active range of the four following digits associated with them. The set of numbers can then be sampled at random. The set will necessarily include businesses and silent numbers. Businesses may be treated as non-response or not be included in a (household-based) sample. If they are to be excluded it may then be

necessary to determine the difference between non-response and a business number. Approximately 15 per cent of numbers are silent numbers. These should be included; market research experience is that people with silent numbers will respond if the survey is seen to be relevant, although they may ask how the number was obtained

Random dialling is usually associated with Computer Aided Telephone Interviewing (CATI). These systems control the surveyor, assisting with recall procedures, follow up calls, etc. They also provide base information on the response to the call. Spatial stratification using random dialling can be carried with reference to the area codes. A description of CATI is given in Beed and Stimson (1985).

*Response rate:* The response rate to telephone surveys is generally lower than that for a HIS. Indications are that 15-20 per cent of calls are not answered. Given the estimated response rates this indicates a need to call perhaps 15 per cent of the households in Melbourne to complete the initial screening survey. A further point concerns the annual repetition of the surveys. If the sample is to be increased each year then there is a problem associated with interviewing the same person twice in each five year cycle. This problem can be overcome but requires the matching of each new set of telephone numbers with the old ones.

*Staging of the survey:* The survey can be staged over a number of years. If as discussed above, 18 000 households were to be surveyed over a five year cycle, annual interviews would be (say) 6000 in the first year and 3000 in each of the following years. The basic information from these surveys could be aggregated into one data set if there are no major variations in the transport network or land use developments.

*Questions:* The questionnaire should consist of a set of basic questions and a flexible section. The basic questions will remain constant from year to year in order to build up a consistent, area-wide database over the five year cycle. The survey process is, however, evolutionary and changes in the policy issues to be addressed may result in the refinement of some questions or the inclusion of others. The inclusion of more questions would lead to an increase in the cost of the survey and analysis. It should be the responsibility of the Transport Information Unit to refine the questions, in consultation with its clients. The flexible section will allow for investigations of particular wording or approaches to asking questions, and enable the questionnaire to focus on different issues each year.

*Expansion and correction of data:* Expansion of the data needs to be carried out at a number of levels. The first relates to non-response. Non-respondents are likely to represent particular groups of transport users (Brog and Meyburg, 1981). These groups may not have transport characteristics that are consistent with the general characteristics of the respondents. General information on the characteristics of the non-respondents can be obtained from preliminary questions and this information used to update the sample. A second, preferable approach to correction and expansion is to use information from the population census to update the sample (Heathcote, 1984). The problem with the census is the fact that it is only carried out every five years and the information from is seldom available for a further year or two.

The suggested approach for data correction is to use non-response information to correct the data each year and to use the census to correct the total data set every five years. An indication of the accuracy of the non-response approach can be gained when the census expansion is carried out.

*Longitudinal study:* The preceding discussion has concentrated on a series of cross-sectional studies. The longitudinal survey focuses on the same population and investigates their reactions to transport initiatives over time, with repeat surveys every two to three years. The initial population of the longitudinal sample should be of the order of 1000 households. Panels of households already exist in Melbourne for the determination of product purchase mixes. There is approximately a 15 per cent annual turnover of members of these panels, and substitution procedures are required for any panel that is initiated.

*Pilot testing:* The system recommended for the travel survey makes extensive use of new information technology and new survey techniques, as these offer considerable savings in cost and reductions in time for the release of the output information. The achievement of these advantages and benefits can only be ensured by a comprehensive system of pilot testing of the travel information system. The resource needs for the new travel survey and the Transport Information Unit fall into three physical categories: time, personnel and equipment.

## **Conclusions**

The basic conclusion of this paper is that a new survey program covering person and freight transport demand for the Melbourne metropolitan area is essential for the continuation of credible transport planning and decision making in the 1990s. The data collected in this program form an essential component of the information needs of the transport portfolio.

The MTSRP project identified and defined a preferred direction for the survey program, as a rolling sequence of surveys, based on stratified sampling, and running on a five year cycle for comparability with the ABS census. The recommended technology for this survey program is a combination of telephone interviews and self-administered questionnaires (with travel and activity diaries), providing survey instruments capable of repeated use over the required time frame. The administration of this survey program and responsibility for the interpretation, analysis and dissemination of the information it collects should be the responsibility of a specially-created Transport Information Unit. The establishment of such a Unit is required to ensure the maintenance of the knowledge and skills required to provide current and credible travel information to the transport portfolio and other interested bodies.

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