Estimation of Small-Area Commercial Vehicle Movements in the Sydney Greater Metropolitan Area: Development, Estimation Issues Addressed and Enhancements to the Estimation Method

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1 Introduction

For many years, development of estimates of commercial vehicle movements in urban areas did not keep pace with that for personal travel movements. Budgets have always been more favourably allocated to personal travel data than commercial travel data (Raimond, 1997), and the complexity of issues in the estimation of commercial vehicle movements has discouraged work in this area. Collecting data on commercial travel was known to be more difficult, more expensive and provided less reliable results than for personal travel (Raimond and Peachman, 1999). In addition, there are more factors affecting commercial vehicle movements that need to be taken into consideration in estimation. For example, the Quick Freight Forecasting Guide (1996) mentions 21 factors that affect freight demand.

In 1996, the Transport Data Centre, now called the Transport and Population Data Centre (TPDC), commenced the *Commercial Transport Study (CTS)*, a project with the ambitious aim of producing small-area estimates of trips by rigid and articulated trucks (heavy vehicles) and light commercial vehicles (LCVs) in the Sydney Greater Metropolitan Area (GMA). These estimates would supplement the existing estimates on personal travel to give a complete picture of vehicle movements in the GMA. After many years of developing and testing an estimation procedure, TPDC has now produced data for 1996 and 2002 and is in the process of further enhancing the methodology as a result of a review of the initial sets of estimates.

This paper discusses how the CTS has evolved since its inception in 1996, the challenges it faced to produce the first set of estimates, and the subsequent and proposed enhancements to the estimation procedure to address some of the issues noted in the initial sets of estimates.

The paper focuses on the CTS estimation procedure only. There are other commercial transport estimation approaches used or being developed worldwide. A comprehensive discussion of these approaches has been presented in the DfT Integrated Transport and Economic Appraisal Review of Freight Modelling Report B2 – *Review of Models in Continental Europe and Elsewhere* (2002). Two more recent studies are the tour-based Commercial Vehicle Model in Calgary (Stefan *et al,* 2005) and the study being developed by the Los Angeles County Metropolitan Transportation Authority which combines logistics/supply chain and tour-based approaches (Fischer *et al,* 2005).

The CTS, similar to these studies, attempts to address the various freight estimation issues confronted by transport researchers. These include understanding the characteristics of urban freight movements, developing freight estimation methods that reflect commodity movements and the role of logistic chains, estimation of movements at detailed geographic levels, and producing reasonable trip estimates given data availability constraints and limitations.

2 The beginnings of the CTS

At the time the CTS started, the only source of detailed commercial vehicle data for Sydney was TPDC's 1991/92 Commercial Vehicle Survey (CVS). The CVS was a well designed and conducted survey, supported by an appreciable budget, but it still suffered from the limitation inherent in any survey – the data was not reliable at small-area level, in this case, the TPDC Travel Zone (TZ) level. Given this limitation, rather than repeat the CVS, TPDC instead decided to devote resources to the development of an estimation methodology that would provide acceptable estimates of commercial vehicle movements.

During the initial phase of the CTS, two reviews were undertaken: a review of data collection methods for commercial transport (FDF Management Report 1997), and a review of current collections and trends in North America (Chow 1997). The FDF review recommended the use of a commodity-based approach for the CTS. The North America review found that the then state of practice tended to follow traditional trip-based approaches, but that there was a trend towards more commodity-based approaches such as that recommended by FDF.

Having considered both reviews, TPDC decided to develop a commodity-based approach for the CTS.

3 The CTS Trip Table Estimation Procedure

In 1998, TPDC engaged DJA Maunsell to develop and test a CTS procedure that was based on the approach recommended by FDF.

To produce the trip matrices for heavy vehicles, TPDC decided to use the CUBE-TRIPS *MVESTM* matrix estimation module. MVESTM allows the use of various available data inputs in the estimation process, thus avoiding having to undertake large-scale and costly surveys. Data that can be used as inputs include vehicle traffic flow counts, prior matrices, zonal level trip ends and vehicle routing and cost matrices. MVESTM uses a *maximum likelihood* statistical technique and allows the assignment of confidence levels on the input data to specify the relative influence of each data item in the estimation process.

For reasons to be explained later, MVESTM was not used for LCV movements. The heavy vehicle estimation process is shown in Figure 1.

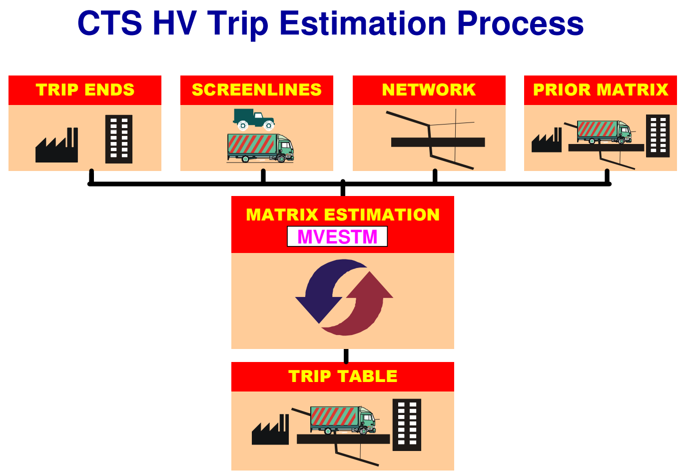


Figure 1 The CTS heavy vehicle trip estimation process

4 Trip Ends

Trip Ends are the number of trips generated from and attracted to a travel zone. In the CTS, trip ends are derived from commodity flow data which is converted to trips for each vehicle type. The trip end estimation process for rigid and articulated trucks and light commodity-carrying (not service) vehicles is shown in Figure 2.

4.1 Commodity flows

In the original design for the CTS it was intended that commodity flows would be estimated using Input Output (IO) commodity flows in dollars which would be converted to tonnes using ‘tonnes per dollar’ conversion factors. However, further investigation at an early stage revealed that there were significant problems in compiling accurate conversion factors of this kind. In addition, IO commodity flows were only available at the national level, which severely limited their usefulness for the GMA. As a result, TPDC decided instead to use a commercially available database of commodity flows by tonnes (*FreightInfo©*) as the starting point for the CTS procedure.

FreightInfo is a database of all freight flows within, to and from Australia. It is owned by FDF Management and is updated every three years. Information on the database includes freight movements (in kilotonnes) by commodity type (using 4-digit FreightInfo commodity codes) by region (using FreightInfo zones) and by mode (road, rail, sea international, sea coastal, pipeline, conveyor, air international and air domestic). The CTS uses a subset of this database (i.e. movements by road to and/or from Sydney GMA). Sydney GMA is represented by 5 zones in the FreightInfo database – Sydney, Gosford-Wyong, Newcastle, Wollongong and Illawarra Balance.

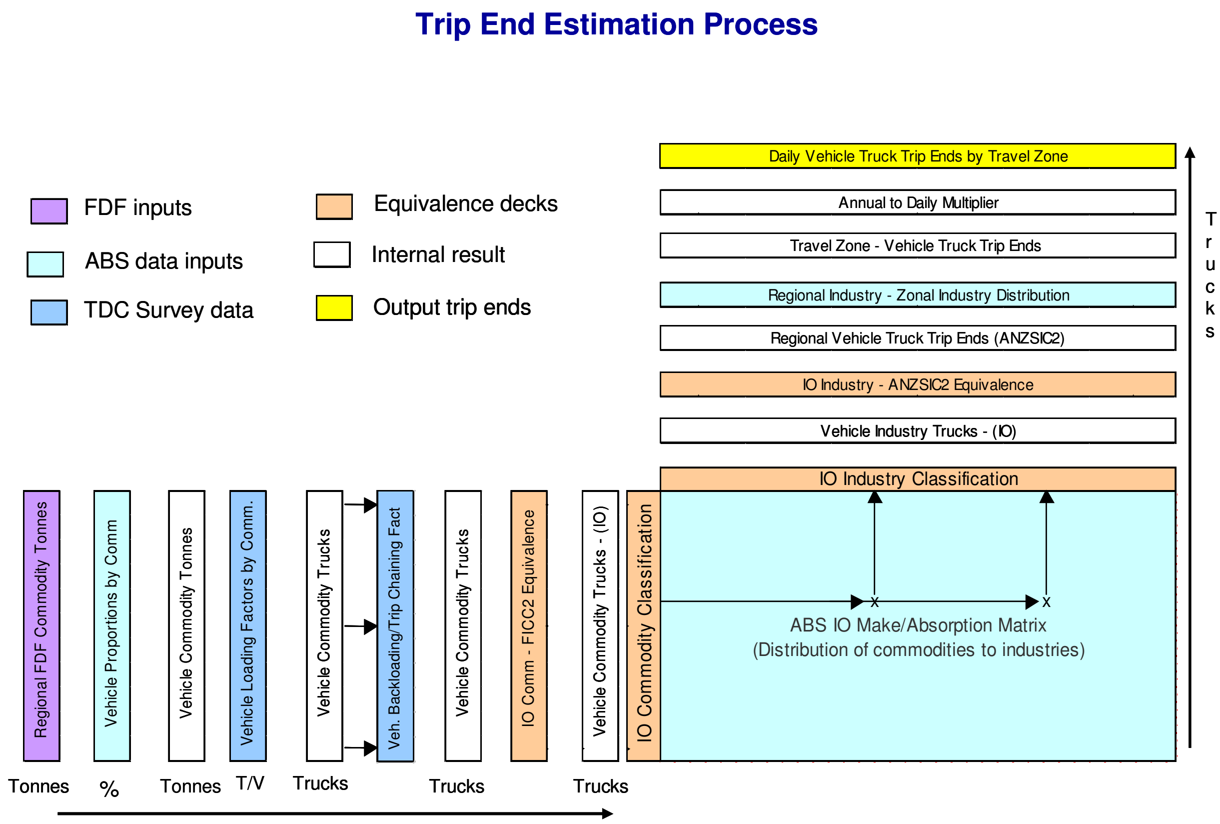


Figure 2 The CTS Trip end estimation process

It must be noted that, as with any other data sources, *FreightInfo* has its own limitations. Because this is a database of freight flows, it does not include some types of commercial vehicle movements which are usually captured in origin-destination surveys such as the CVS (e.g. movements of road-base/fill, tow trucks, household garbage collection, service vehicle/tools of trade trips, drop off/pick up and empty trips, and trips of a private nature such as home-based return trips or trips to refill fuel).

TPDC has attempted to address most of these exclusions in the CTS estimation process. For example, in the trip end estimation, trip chaining and backloading factors were used to account for commercial vehicle drop offs/pick ups and empty trips. Also, for LCVs, the CTS estimation included a service vehicle trip end estimation component which uses household- and business-based service vehicle trip attraction rates (to be explained in a later section) so that trips made by non-commodity carrying LCVs are included in the CTS estimates.

However, the CTS current estimation methodology has not directly adjusted for the other excluded trips such as household garbage collection, driver work to home trips, road-base/fill and service station trips, which are usually shorter trips.

4.2 Converting tonnes to trips

Vehicle type split

The first step in converting the tonnages to trips is to distribute the commodity (road) tonnages to the three vehicle types – LCV, rigid and articulated trucks.

TPDC considered three data sources to obtain the vehicle type split. These data sources were the 1991/92 CVS, the 2000 CTS Industry Survey and the ABS Survey of Motor Vehicle Usage (SMVU).

- *1991/92 CVS* - The main advantage of using this data source is that the CVS was a large-scale origin-destination survey and covered Sydney GMA. Therefore it could provide a realistic picture of the vehicle choices of industries in the CTS study area. However, this data source was not selected mainly because the survey is too old and may no longer reflect current industry vehicle choices as affected by new markets and logistics system.

- *2000 CTS Industry Survey (CTS IS)* – Initially, TPDC intended that this data would be used for the vehicle type split. However, it was discovered that the results appeared to overestimate articulated truck usage, possibly due to two reasons. First, there was an over-representation of large freight-generating establishments in the survey and these establishments reported greater use of articulated trucks. Added to this, there was a definition problem with participating mining/quarry companies which reported their rigid trucks with trailer (i.e. "truck and dog") as articulated trucks. These trucks are mainly used to transport quarry products.

- *ABS SMVU data* - Vehicle proportion factors can also be derived from the SMVU special tables on *tonnes carried by commodity type (1-digit) by commercial vehicle type.* This data is available only at State and national level. There are a number of advantages in using the SMVU. It has a much wider representation of industries and commodities, data is available regularly (which means we can keep track of changes in mode split), and it is based on a statistically rigorous sampling procedure. The main disadvantage is that the data on vehicle split is associated with large RSEs (Relative Standard Errors) even at the NSW level (mainly over 20%). TPDC had two choices – to use the NSW data or to use the national level data which has lower RSEs. Although, the national level data has lower RSEs, the NSW data was preferred, as the Sydney GMA commodity mix would be much better reflected in the NSW data than it would be in the national level data.

Based on the above considerations, TPDC decided that the NSW SMVU data would be used to obtain the vehicle proportions for the trip end estimation.

Table 1 is presented below to show an example of the effect of the choice of which data to use to obtain vehicle proportion factors. The example is for articulated trucks.

Table 1 Comparison of vehicle proportions for articulated trucks

	FDF Data	Vehicle Proportions			Estimated Articulated Tonnes		
Commodity description	**Tonnes ('000)**	**CVS**	**CTS IS**	**SMVU**	**CVS**	**CTS IS**	**SMVU**
Food and live animals	41,492	45%	75%	62%	18,672	31,119	25,725
Beverages and tobacco	3,293	34%	63%	52%	1,120	2,074	1,712
Crude materials, inedible, except fuels	86,980	39%	82%	34%	33,922	71,324	29,573
Mineral fuels, lubricants and related materials	48,922	85%	99%	68%	41,584	48,433	33,267
Animal and vegetable oils, fats and waxes	1,642	84%	69%	84%	1,380	1,133	1,380
Chemicals and related products, nes	29,392	72%	43%	44%	21,163	12,639	12,933
Manufactured goods	67,577	38%	41%	34%	25,679	27,707	22,976
Machinery, transport equipment	54,339	32%	32%	51%	17,388	17,388	27,713
Miscl manufactured articles	17,180	14%	50%	31%	2,405	8,590	5,326
Commodities and transactions, nes	6,581	58%	50%	31%	3,817	3,290	2,040
	357,398				**167,129**	**223,697**	**162,645**

(Note: Tonnage data is from the 2001 FDF FreightInfo Data for GMA).

Further detailed study on vehicle proportions will need to be undertaken in the GMA in the future to validate the proportions selected.

Tonnes to vehicle factors

After the tonnages are distributed to the vehicle types, the next step is to convert the tonnages to trips using three factors:

- Vehicle Loading Factors
- Backloading Factors
- Trip Chaining Factors

When the CTS started, there was insufficient data from any previous studies to provide these factors for the GMA. Consequently, TPDC needed to undertake its own study specifically designed to obtain the factors. The TPDC *2000 Industry Survey* provided the factors to convert from commodity tonnes to trips that are used in the CTS.

The CTS Industry Survey had two components – a face-to-face interview survey consisting of industries known to be large freight generators in the GMA (as determined from the FDF regional commodity flow) and a telephone interview survey from a cross section of industrial establishments in the GMA. There were 89 establishments that fully participated in the face-to-face survey and 510 establishments for the telephone component. The establishments surveyed provided a rich dataset of information on commodity movements (947 outgoing commodities and 1,056 incoming commodities) that enabled TPDC to produce the commodity- and vehicle type- specific tonne-to-vehicle factors required in the estimation.

Loading Factors

Vehicle loading factors are applied to the commodity tonnages to estimate the *base* vehicle movements arising from the commodity flows. These base vehicle movements do not include additional trips arising from some trip chaining and backloading activities. Loading factors were derived from the survey questions on the vehicles *leaving* the establishments, the commodities carried and the amount of load they carry. Only outgoing commodities were included because information on incoming commodities relates only to the proportion of load that was dropped off by the vehicle rather than the total vehicle load during its journey (which is not known to the receiving establishment).

Backloading Factors

Backloading factors are calculated to ensure that empty commercial vehicles returning after a completed delivery are represented in the trip end estimates. The backloading factors used in the CTS are based on questions in the Industry Survey to provide information on the load status of vehicles i.e. whether they were empty, full or part full, and whether they dropped off/picked up freight on arriving at the establishment.

Trip Chaining Factors

Trip chaining refers to intervening drop offs/pick ups made during a commercial vehicle trip from the primary origin to the primary destination. Trip chaining factors are necessary to ensure that these intervening trips are enumerated in the trip estimation process. The trip chaining factors used in the CTS are based on questions in the Industry Survey to provide information on (1) the proportion of trips where trip chaining occurs, and (2) where trip chaining occurs, the average number of drop offs/pick ups.

The end result of this process is a set of factors that act as a multiplier (values > 0) to describe the number of trip chaining trips that occur for each regional-commodity combination.

4.3 Converting regional data to travel zone level

FreightInfo commodity data is only available for broad regions within the GMA (Sydney, Gosford-Wyong, Newcastle, Wollongong and Illawarra Balance). To convert this regional data to travel zone level, TPDC uses travel zone level *employment* by industry data from the Census Journey To Work (JTW) dataset. The availability of good employment data (i.e. data is taken from a population census rather than a sample survey) at the travel zone level makes this data item the most suitable indicator of the zonal distribution in a commodity-driven trip estimation method.

Because *FreightInfo* tonnages are for *commodities* and not *industries*, there are several steps required before the regional trips can be distributed to the travel zones. These are:

- Converting the 2-digit FreightInfo Commodity Codes (FICC) to the IO commodity codes.
- Using the IO *Make* table, the IO origin *commodity* trip ends are distributed across the IO *industries* that produce them.
- Using the IO *Absorption* table, the IO destination *commodity* trip ends are also distributed across the IO *industries* that consume them.
- Next the IO industry codes are converted into JTW industry codes (ANZSIC 2-digit) using an IO Industry-to-ANZSIC Industry equivalence table. The result is regional commodity trip ends for each ANZSIC 2-digit code for each vehicle type.
- The final step is to distribute these trip ends to the travel zones using the JTW industry by employment data. This is done by first obtaining the share of the travel zone to the total regional employment for each industry then applying this proportion to the total regional trip end for that industry. This process ensures that the allocation of trips to the travel zones is based on how much employment is located the zones for each industry.

There are two issues associated with this general methodology. Firstly, the IO Make and Absorption matrices, while broadly useful in showing the connection between industries, do not necessarily take into account distribution networks that have a significant impact on the actual distribution of truck trips across industries. As a result, key distribution nodes such as ports, freight terminals, warehouses and distribution centres do not get a high enough share of the final trip end distribution. This finding is supported by other studies that found that the application of commodity flow techniques have deficiencies in handling estimation of movements for secondary handling facilities such as warehouses, distribution centres and terminals (Fischer *et al*, 2005).

For its initial CTS estimates, TPDC addressed this issue by examining key distribution nodes and *manually* adjusting trip ends appropriately. However, for the 2003 CTS estimates, TPDC intends to enhance the process by making fuller use of its Industry Survey, which provides data for individual commodities on the proportion of trips moved to/from distribution nodes (i.e. freight terminals/ports, distribution centres/warehouses, and wholesalers/retailers) rather than to the primary industries directly.

Secondly, using *total* employment data will at times incorrectly distribute the trips to travel zones. For example, manufacturing employment in the Sydney CBD is comparatively high because many manufacturing companies have their head offices located in the CBD. If total manufacturing employment were used to determine the zonal shares of manufacturing-based truck trips then CBD zones containing administrative offices for manufacturing companies would get an unrealistically high number of trips allocated. This is known as the 'Head Office Problem'. To address this issue, TPDC decided to use 'production only' employment (i.e. managers and administrative staff were excluded) rather than total employment when using manufacturing employment data to estimate zonal shares of manufacturing trips. Although the impact of the Head Office Problem is not as great for other industries as it is for manufacturing – and the differentiation between 'administrative' and 'production' employment is not always so clear - TPDC is investigating the use of production-only employment for other industries for its 2003 CTS estimates.

It is important to note that because the CTS process for estimating zonal level data from region level data is based on zonal employment data, *forecasting* using the CTS process must use *zonal level employment forecasts*. An issue here is that the current employment forecasting model used by TPDC is a general model that does not at this stage specifically deal with the needs of CTS forecasting i.e. the employment forecasting model does not contain higher-accuracy sub-models for key freight-generating industry sectors (Manufacturing, Mining etc), that take into account, for example, changes in productivity that will impact on employment in those sectors. Since the use of zonal employment data in the CTS is really a proxy for zonal *production* data (which is not available), it is essential for CTS forecasts that such sub-models are developed. TPDC will be concentrating on developing these sub-models for its next update of its employment forecasts

4.4 External zones

There are five external zones used in CTS estimation to represent movements between the GMA and areas outside the GMA: South Coast (via Princes Highway), Southern Highlands (via Hume Highway), Blue Mountains (via Great Western Highway), Inner North (via New England Highway) and North Coast (via Pacific Highway). These external zones represent both intra-NSW and interstate movements e.g. the Southern Highlands zone includes data for movements between the GMA and Melbourne as the Hume Highway is the major route for such trips.

Ideally, trip estimation for external zones needs to undertaken as a partially separate process to that used for other zones This is because the characteristics of trips to/from external zones are significantly different to intra-GMA trips. As long-haul trips, they have a different commodity mix, a different vehicle type mix (articulated trucks are predominant), higher average loads (full loads predominate), and different backloading and trip chaining characteristics (much less than short-haul trips).

For resource reasons, TPDC has not yet fully implemented special processing of external zone data. However, it is intended that this will be completed for the 2003 CTS estimates. Currently, for example, the prior matrix used (based on the 1991/92 CVS) inadequately reflects current movements between the GMA and the rest of NSW and interstate (see Section 7). For 2003, TPDC will use an external zone-specific matrix based on regional FreightInfo data.

5 Screenlines

The second input to the CTS matrix estimation process is screenline counts. Screenline counts are used to optimise the assignment of trips to the network and hence the final origin-destination matrix. In the initial phase of the CTS there was no comprehensive set of reliable heavy vehicle counts available for the GMA. In the absence of such counts, TPDC initially estimated counts based on assumed proportions of rigid and articulated trucks applied to available AADT (Average Annual Daily Traffic) data.

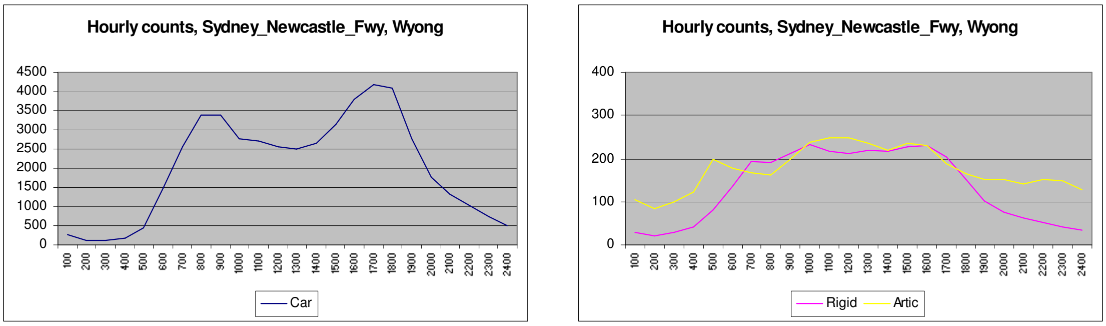
The unavailability of reliable heavy vehicle counts in the early days of the CTS was largely due to the fact that at that stage there was no *automated* method for collecting accurate classified vehicle counts on urban roads. For example, it was known that when using tube counters there were significant inaccuracies in classified counts during periods of congestion. Given the critical importance to the CTS of having accurate screenline counts, TPDC decided to conduct its own study, the *Commercial Vehicle Count Study 2002*, which investigated the nature and extent of inaccuracies in the collection of classified counts on urban roads using tube counters (Mendigorin *et al.* 2003). As part of the study, the study consultants, CFE Pty Ltd, developed a methodology and software to provide acceptably reliable and relatively inexpensive classified counts using tube counters.

As a result of the developments by CFE, TPDC was able to access a comprehensive and reliable set of classified counts to use for its screenlines in the CTS. An additional benefit from this was that it was also now possible to obtain reliable heavy vehicle counts by time of day. This was important because the pattern of heavy vehicle movements throughout the day is not necessarily the same as that for cars as can be seen from the graphs in Figure 3. As a result of having reliable time of day screenline data for heavy vehicles, TPDC is now able to produce CTS estimates by time period as well as for average day.

Even with the availability of reliable screenline counts, for the CTS there is an issue that needs to be addressed with one of the classified count categories. The ‘Class 3’ category (based on the AustRoads Vehicle Classification system), which applies to rigid 2-axle vehicles, includes *buses* as well as trucks. Clearly, for the CTS, buses need to be excluded from any Class 3 counts.

For its initial CTS estimates, TPDC dealt with the problem of buses by simply excluding screenline counts for sites known to have a very high proportion of buses in the Class 3 category. However, TPDC now has access to bus timetable data which means that accurate bus counts for each screenline site are available. As a result, from the 2003 CTS estimates, TPDC will be able to remove the bus component of Class 3 counts for all sites and therefore improve trip estimates based on these counts.

Road link to north of Sydney GMR



Road servicing CBD

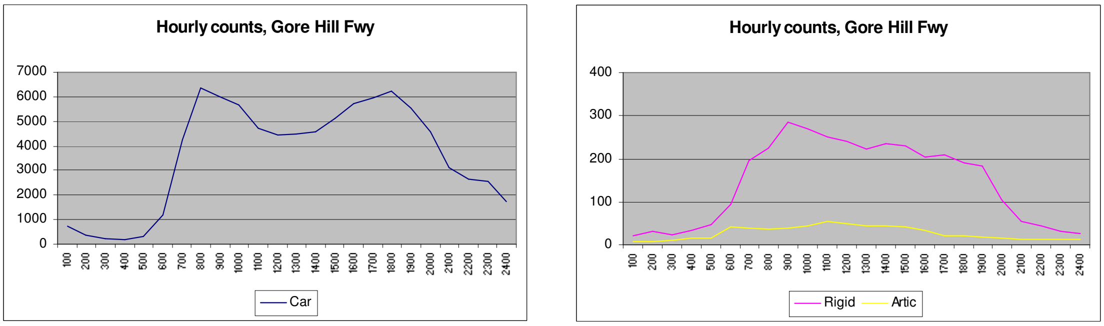


Figure 3 Car and heavy vehicle hourly counts (Classified Vehicle Counts Study)

6 Network

The network used in the CTS was obtained from the TPDC Strategic Travel Model (STM). The current network consists of 1,114 travel zones (including the 5 external zones). A private vehicle matrix was also obtained from the STM as input to the process. The private vehicle matrix was assigned to the network and path files were created, saved and then merged as input to produce the Route Choice probability (RCP) file used in MVESTM. MVESTM uses this RCP file along with the screenline data to create a more efficient file called the *Intercept File* which is used in the distribution of trips across the travel zones.

7 Prior Matrix

In the CTS matrix estimation process, a prior matrix can be used. A prior matrix is a seed matrix that provides the initial shape of the trip matrix. The prior matrix, along with the trip ends and screenline information are used to derive the final matrix. Confidence levels are assigned to these data inputs to determine their relative influence on the matrix estimation process.

In the initial stages of CTS development, the only source of data for a prior matrix for the CTS was the 1991/92 CVS. However, the usefulness of CVS data for this purpose was limited both because of its age and the fact that it could not provide reliable origin-destination data at a travel zone level. As a result, though a CVS-based prior matrix was used for the initial CTS estimates, TPDC allocated it a low confidence level compared to trip ends and screenlines.

For the 2003 CTS estimates, TPDC will improve the prior matrix by incorporating known distributions from ports from recent studies (e.g. *NSW Import Export Container Mapping Study*, SFC 2004) and using FreightInfo information on external zone movements so that the distribution of the external zones in the prior matrix will be greatly improved.

8 Trip Table Estimation (Heavy Vehicles)

Once all inputs are prepared, confidence levels are assigned to the input data and the MVESTM module is run. In the CTS, relatively higher confidence levels were given to the screenline and trip ends than the prior matrix. Numerous runs are undertaken and analysed and input data are reviewed where there are substantial discrepancies between the input data. Where a particular data item is dubious or roughly estimated, the confidence level can be reduced, unless there are valid ways to adjust the input data item.

Evaluation of output includes:

- checking the MVESTM output print files to look for the correspondences between the input data and the estimated results (e.g. comparing the prior and estimated matrix results, observed and estimated screenline results);
- undertaking trip length analysis;
- checking the levels of trips generated for major freight zones such as ports and major industrial centres;
- producing summary counts and checking results against external indicators, e.g. summing up trip estimates at Statistical Local Area (SLA) level and comparing with other available freight related data at SLA level;.
- For the 1996 and 2002 results, comparing the growth in commercial vehicle trips from the two estimates with growth in employment and any other economic indicators for the region between 1996 and 2002.

9 Trip Table Estimation (Light Commercial Vehicles)

The light commercial vehicle estimation is run using the TRIPS MVGRAM module and uses trip ends and a cost matrix to distribute the trips across travel zones. The MVESTM module is not used for LCV estimation because currently there are no available LCV screenline counts to use as an input to the process (LCV counts cannot be obtained from tube or other automated counters, because whether a vehicle is an LCV depends on *function* as well as the vehicle type). Figure 4 shows the LCV estimation process.

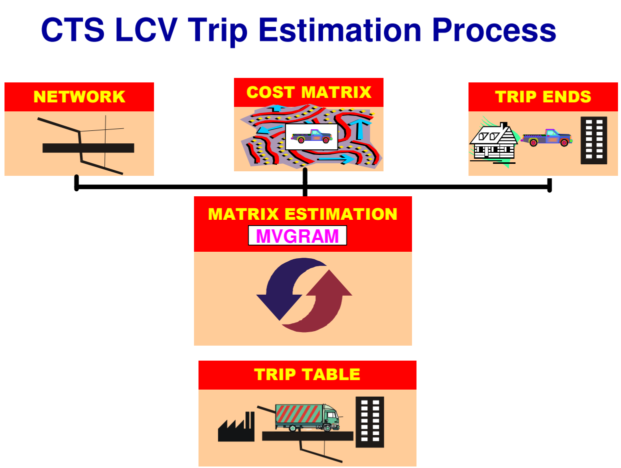


Figure 4 The CTS LCV trip estimation process

9.1 LCV Trip Ends

Estimating LCV trip ends consists of two estimation procedures:

- For commodity-carrying LCVs the same trip end process is used as that for heavy vehicles. This process has been discussed in the earlier section.

- For light service vehicles, the trip end estimation process uses data from the TPDC Service Vehicle Attraction Rates (SVAR) study.

The SVAR was a study undertaken by TPDC in 1999 to measure the attraction rates of LCVs to households and business. The study had two components - a *Household* Attraction Rates survey and a *Business* Attraction Rates survey..

The SVAR Household Survey collected information on the number of service vehicles that visit households over a one-week period. The SVAR Business Survey collected information on the number of service vehicles visiting businesses over a one-week period.

A detailed report on the results of the SVAR was presented in Peachman and Mu (IATBR 2000). From these two survey components, the following information was used in the LCV trip end estimation:

- Average number of service vehicle trips per household – This is multiplied by the total number of households per zone to obtain the destination zonal trip ends for household-based service vehicles. The zonal origin trip ends were estimated by first summing up the zonal destination (household) trip ends and then distributing this total across all origin travel zones using zonal employment by service industries.

- Average number of service vehicle trips per employment – This is multiplied by travel zone level employment by industry to obtain the destination zonal trip ends for business-based service vehicles. Similarly, the zonal origin trip ends were estimated by first summing up the zonal destination (business) trip ends and then distributing this across all origin travel zones using zonal employment by service industries.

Because the SVAR was a small study in terms of sample size, and was conducted in 1999, the service vehicle attraction rates generated from the study (particularly the business attraction rates) may now need updating. TPDC will be looking at conducting another SVAR, study in the future.

9.2 Cost Matrix

There are no available screenline data for LCVs because these are included in the cars category under the AustRoads axle-based classification system. In the CTS Classified Vehicle Study, some information on the proportion of LCVs to total traffic was obtained from video audits of the sites. However, the video audits were only undertaken for two hours for each site, so it is difficult to establish the overall proportion of LCVs to total traffic using this information.

The current lack of screenline counts for LCVs coupled with a dated prior matrix from the CVS means that there is little value in using the TRIPS MVESTM module. Thus a gravity model is currently used for estimating the LCV matrix.

10 Day type and time period analysis

Initially, the CTS estimates referred only to *average day* estimates. Recently, TPDC released its first set of estimates by day type (i.e. average day, average weekday, average Saturday and average Sunday) and by time period (i.e. AM Peak, Day off-peak, PM Peak and Night).

The estimation process relied heavily of the analysis of 7-day hourly screenline data. The estimation process was the same as that for the average day except that day type and time period factors have been applied to produce the estimates. Because there are separate screenline counts for rigid and articulated vehicles, the day type and time period factors for these vehicle types were separately estimated.

As this was the first time that TPDC had undertaken this detailed time of day estimation, there is a need to further review and validate the results from this process.

11 Summary and Future directions

The CTS has evolved from a concept to a practical and acceptable process for estimating small area commercial vehicle trips in an urban area. Although it continues to face a number of issues, it has slowly identified the areas that need improvement and has come up with possible ways of addressing them.

While the CTS relies to a great extent on available external data (such as the FDF *FreightInfo* data, and the ABS SMVU, IO make and absorption matrices, Census JTW), it also relies heavily on various studies conducted by TPDC itself to capture the commercial vehicle travel patterns specific to Sydney GMA. These studies include the Commercial Vehicle Survey, the CTS Industry Survey, the Service Vehicle Attraction Rates Study, and the Classified Vehicle Counts Study.

In the future, TPDC will be looking at enhancing the CTS process through the following:

- *An enhanced estimation process* - The CTS is currently in the process of producing trip estimates for 2003 with some improvements in the estimation procedure based on findings from the first two sets of data released earlier as discussed in this paper. The proposed changes to the estimation process are summarised below:
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    - Separate trip end estimation for internal and external trips;
    - Use of the Industry Survey results to more appropriately distribute the trips across industries to produce more accurate estimates of trips from secondary industries such as distribution centres/warehouses, freight terminals/ports, wholesalers and retailers;
    - Adjustment of JTW employment by industry to further remove from the data the impact of non-production based occupations, which particularly affects estimation for areas with large head offices, such as the CBD;
    - Enhancement of the prior matrix to incorporate results from recent port studies and to use the FreightInfo data on external zones to improve the current prior matrix;
    - Obtain additional screenline data and fully remove buses from the Class 3 vehicle counts.

- Continuing efforts to obtain accurate input data for GMA.
    - *LCV data* - The CTS to date has prioritised on improving the heavy vehicle estimation procedure. As a result, the current process of estimating LCV movements, though serviceable, could be significantly improved. With this mind, TPDC will be considering whether special studies to obtain better LCV-related data can be developed and financed.
    - *Vehicle factors* - The accuracy of the CTS estimates relies heavily on the use of correct vehicle proportion, loading, backloading and trip chaining factors. Therefore, the CTS may also need to repeat and/or expand its Industry Survey undertaken in 2000 to determine whether there needs to be some changes to the factors used in the trip end estimation. Repeating this type of survey will also ensure that information can be collected on commodity movements by type of day and time period required for the day type and time period matrix estimation.

- Developing a forecasting procedure that would take into consideration the approach used in this base estimation process.

The CTS experience proves that although commercial vehicle estimation at the small area level in an urban environment is a very complex and time-consuming activity, commitment to a practical and realistic framework can provide output sufficiently useful to encourage users of the data to financially support ongoing development of the process. With such development, TPDC believes that the CTS can provide a very robust and reliable process for estimating commercial vehicle trips. It is hoped that this paper and the issues it presented have provided some useful insights for those who are intending to design or are currently working on their own commercial vehicle estimation process for an urban area.

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