Session 7.1: Traffic Survey Handouts

The following handouts comprise various methods used in traffic surveys:

- Methods for counting rural traffic in developing countries
- Vehicle classification charts
- Traffic count forms
- Origin-Destination forms

Methods for Counting Rural Traffic in Developing Countries

The results of the questionnaire survey among a sample of developing countries suggest that decisions on the duration, frequency and timing of counts are at present arbitrary. Consequently, estimated daily traffic flows can rarely be expected to lie within ±30% of the true value averaged over the whole year. Although repeating counts at intervals throughout the year increases the accuracy of traffic estimates, this is achieved only at a disproportionate increase in cost. For any appreciable increase in the accuracy of rural traffic estimates much more needs to be known about the magnitude and causes of the variations in flow. This requires that automatic traffic counters are used on a wider scale than at present.

Duration of counting

The most common period for counting is 12 hours (6am - 6pm or 7am - 7pm) repeated for 5 or 7 days. The complex 8-hour count each day for three weeks, that is proposed for some stations in Thailand, can be regarded as an effective 24-hour count for 7 days.

Frequency of counting

For 'national' censuses (counts made annually over the entire country) the frequency of counting varies considerably from country to country, from one to four times a year. Where the frequency is more than once a year, it is usually related to the number of major climatic seasons.

Timing of counts

The timing of counts is not generally standardised; however, for 'national' censuses some countries specify broad wet and dry (or harvest) seasons when counts will, or will not, be made. Thus, in respect of their timing, traffic counts in developing countries can be considered as random samples. The period for counting, however many hours and days it comprises, is effectively a random selection in that any period in the year (other than a few containing obviously unusual activities, such as Easter or Christmas), can be chosen. Even when, as in some of the national censuses, certain months or periods are specified, sampling is still essentially random since there is no evidence that the period chosen is selected on the basis of a known pattern of seasonal variation. Also, experience has shown that in practice these periods are, regrettably, rarely adhered to. In some developing countries the purpose of traffic counts is not always clear. It might be to provide estimates of average daily traffic in the specified week, month, or year, or merely the average flow during the observation hours.

The quantity to be estimated

Although it is rarely explicitly stated, rural traffic counts usually attempt to measure average rather than peak usage. The commonest measure of average usage is the amount of daily traffic. However, the word 'daily' sometimes refers to a period of less than 24 hours. In the United Kingdom rural traffic counts are taken to be the 16-hour (6am - 10pm), seven-day, average flow occurring in August. All current counting systems based on 'm-hour days' (where m <24) suffer from a number of drawbacks. Since m varies so much between countries this suggests that the particular value chosen is arbitrary. Certainly it is not normally possible or meaningful to

assign limits of error to the traffic estimates that result. Further, the 'm-hour' days are not natural periods of human activity such as the day, week or month. Thus, variations in traffic flow characteristics, which can only add to estimation errors, are to be expected, e.g. the distribution of traffic through the hours of the day will vary with route characteristics: the distribution on a major trunk route carrying a large proportion of goods vehicles is unlikely to be the same as that on a farm-to-market road.

In the USA, the term 'daily' traffic has its normal meaning: the flow of vehicles passing a given location in 24 consecutive hours. The basis of American traffic observations is the quantity 'Average Annual Daily Traffic' (AADT), which is defined as the 'Annual average number of vehicles during 24 consecutive hours that pass a particular point on the road over the period 365 days'. This term would seem to have a number of advantages not shared by the various 'm-hour' days. It is unambiguous, readily understandable, and corresponds with a natural period of human activity. Thus it eliminates those problems associated with variations in the hourly distribution of traffic in different locations. However, the most important advantage of the AADT concept is that it enables statistical methods to be applied to the problem of rural traffic counting. Generally, it would seem to be the most logical basis for traffic observations and is the one used in this analysis.

Errors in estimates of AADT from sample counts

Only where continuous counts are made under perfect conditions can a true AADT or total year's flow be computed with the expectation of its being absolutely accurate. It follows that any count of less than one-year's duration must be regarded as a sample, and the estimate of AADT or total year's flow made from it will be subject to error. The error of estimation is simply the difference between the estimated AADT and the true AADT. If the mean and the standard deviation of these errors are calculated, then probability analysis can be applied to determine, for a given level of confidence, how accurate an estimate of AADT is provided by a particular sample period or sampling procedure.

The method of error determination used in the analysis followed the above principles. For a given duration of counting, repeated samples were drawn from the actual flows recorded at each site in one complete year. From each estimated daily flow (ADTE), the true value (ADTT) was subtracted to give the error of estimate. The resulting errors were divided by ADTT and multiplied by 100 to give the proportional error of estimate in percentage terms. This was done so that errors obtained at sites with different flow levels would be on a comparable basis.

Thus:
proportional error of estimate = $$100 \left(\frac{ADT_E - ADT_T}{ADT_T} \right) \text{ per cent}$$

Finally the standard deviation and the coefficient of variation of the percentage errors were calculated.

Sample testing
The errors resulting from the following ADT sampling procedures were determined:

1. Random samples of 1, 2, 3, 4 and 5 weekdays and 7 consecutive days for all possible periods in the year except those including a Public Holiday.
2. As in 1 for periods of 1, 2, 4, and 6 whole weeks.
3. Random samples of 1, 2, 3 and 5 weekdays and 7 consecutive days repeated at regular intervals of three, four, and six months. To provide samples of a reasonable size it was necessary to group the sites by flow level as follows:

Group 1 (AADT < 75 vehs/day)

Group 2 (AADT 76-200 ")

Group 3 (AADT 201-600 ")

Group 4 (AADT 601 -1000 ")

Group 5 (AADT > 1001 ")

Desirable accuracy of estimates of traffic flow
To judge the results of the sample tests objectively, it is necessary to decide what level of accuracy estimates of traffic should attain. Specifically we must state within what range of error we wish our estimates of AADT to lie, and how certain we need to be that the estimates lie within the stated range. In the USA the accepted standard is that there should be only a 1 in 20 chance (5 per cent level of probability) that the error of estimate will exceed ± 10 per cent at any sample count site carrying over 500 vehicles/day. For roads with lower flows, errors of up to ±20 percent are acceptable.

It might be felt that developing countries cannot afford such high standards as the USA, since, the more precise estimates must be, the greater the cost of obtaining them. However, it is considered that accuracy standards in developing countries should be similar to those quoted, and in fact should tend towards the higher of the two, even for roads with low traffic flows. Whereas the use in the USA of lower accuracy standards of traffic counting for roads with low traffic flows is justified to some extent by the relative unimportance of such roads in the USA, the main aim of road improvements in most developing countries is progressively to upgrade earth and gravel roads to bituminous-surfaced roads, i.e. stage construction, when the level of traffic demands it. A reasonable standard of traffic estimation is therefore required even for roads with low traffic flows. Lowering the confidence limits at which estimates are judged does not seem to be worthwhile since the results rapidly lose any real significance.

Until precise studies are completed of the cost-effectiveness of various methods of traffic counting and the sensitivity of the highway planning process to errors in traffic estimates, it will not be possible to specify desirable accuracy limits for developing countries. The USA standards will, however, serve as a criterion by which to judge the performance of estimating procedures elsewhere.

Practical limits to sample duration
The most critical consideration to whether there are likely to be any practical limits to the duration of counting in developing countries is whether counts will be made manually or by machines.

Experience of conditions in developing countries suggests that the great majority of counts will continue to be made manually. The use of automatic counters is at present uncommon and they are only gradually being introduced, mainly for the measurement of seasonal variation and long-term traffic trends. The more widespread use of automatic counters for general counting seems unlikely for some time to come since they are expensive to buy. Also, they require skilled supervision and maintenance if accurate results are to be obtained, and the necessary skills take time to acquire. Lastly, manual methods have the advantage of giving classified counts of traffic flow, and they may also be politically desirable because of the generally acute unemployment problems.

If manual methods of counting are used, then a one-week continuous count is about the practicable maximum. Apart from the probable loss of accuracy caused by the boredom of the enumerators, longer counts at each point would reduce the coverage of the road system that was possible. In practice, many counts, although spanning seven days, will probably be for less than 24 hours on some, and possibly all days. Night-time counts are unpopular and difficult to supervise effectively, especially in distant rural locations.

Cost-effectiveness considerations also indicate the need to keep the duration of counting as short as possible. Since wages are the main element, the cost of traffic counting can be assumed to increase in direct proportion to its duration. However, simple sampling theory suggests that the accuracy of the resulting ADT estimates is likely to increase in proportion to the square root (approximately) of the duration of counting, i.e. other things being equal, a count for four days will only double the accuracy of ADT estimation in comparison with that obtained from a single day's count, whereas the cost will have risen by a factor of four.

Outcomes
In most countries traffic variability increases rapidly below flows of approximately 1000 vehicles per day. Partly this is a consequence of the law of small numbers: when the total flow is low a unit change has a proportionately bigger effect than when the total is large. Also, in practice, variation is inherently greater at low flows because the traffic stream is composed of fewer individual trip motivations, i.e. a flow of 20 vehicles per day on a given road may be motivated entirely by the travel demands of a small government administrative centre, a school, or a single agricultural enterprise. Any change in its activities, such as school holidays, or crop harvesting, can produce very large relative volume changes. Conversely, on roads carrying 500 or more vehicles per day, the trips are usually motivated by a wide range of activities whose operational variations tend to be mutually balancing. When the travel demand for one is high another will be low and vice-versa. Between these two extremes there is a gradual

transition and one would expect a steady decrease in variation with increasing flow of traffic.

The increase in traffic variability below flows of approximately 1000 vehicles per day is significant because in many developing countries the majority of the rural road system carries daily flows less than this. In Jamaica (1964), Zambia (1964), and Kenya (1970), the percentages of the rural road system carrying less than 1000 vehicles per day were 95, 98 and 95 respectively. Thus in developing countries rural traffic estimation is especially difficult because of the inherent variability of daily travel.

Repeated random samples

The errors in estimates of repeated random counts are related to those obtained from single random counts. If a random count of duration d gives an error equal to ± x, then repeating the count will reduce the error to ±

$$\frac{0.94x}{\sqrt{n}} \; where \; (n > 1)$$

where n is the number of repetitions (i.e. the errors from repeated counts are approximately proportional to the inverse of the square root of the overall duration of counting).

As might be expected, repeated counts give more accurate estimates of ADT than continuous counts of the same duration and the advantage increases with the number of repetitions. Repeating a count twice reduces the errors in estimates to approximately 22 per cent of their continuous count value, and repeating four times results in a 40 per cent reduction. However, only at the highest flow levels and for counts repeated four times do the errors in estimates approach the desirable standard of ± 10 per cent. Below traffic flows of 600 vehicles per day, repeating counts 3 or 4 times generally results in errors in estimates of between ± 10 and ± 20 per cent.

Because of organisational difficulties, repeated counts are unlikely to be regarded as a practical proposition for most data requirements, although they may be of use for one-off studies. Also they cannot generally be expected to produce estimates of a desirable accuracy.

Sampling errors for individual months

It seems likely that random samples drawn from particular months might show errors considerably different from those drawn throughout the year. If a wet season falls consistently in a particular month and normal travel is likely to be interrupted by rain, then samples from that period can be expected to have higher-than-average errors. Conversely, other months, between seasons and away from Public Holidays, could have virtually constant near average flows, and consequently very low sampling errors.

Use of automatic traffic counters in developing countries

When first introduced into developing countries, automatic counters should be operated continuously at fixed locations. These should be chosen to represent the major traffic routes and geographic areas. As well as monitoring

long-term trends, the counter results will enable a study to be made of the magnitude, frequency, and causes of the day-to-day and month-to-month, fluctuations in flow. A clear understanding of these will enable methods of counting traffic to be designed along the lines indicated, so that ADT estimates of a prescribed accuracy can be made. After one or two years, additional counters could be obtained and a start made on the grouping of road sections according to their seasonal variation characteristics. In the USA seasonal variation counts are made for only one week in every month at a given location; with efficient organisation, a single counter can therefore cover four sites per year. In the initial stages of such a system, there is no need for expensive makes of traffic counter to be used.

In summary

1. Traffic counts in developing countries should seek to provide estimates of the Average Annual Daily Traffic (AADT) on a road.
2. If made manually neither simple random traffic counts nor repeated random counts of any practicable duration can provide estimates of ADT within desirable limits on the majority of roads in developing countries.
3. Any appreciable improvement in estimates of traffic flow in developing countries will require the use of automatic traffic counters operated continuously at fixed locations.

Source: Howe, J. (1972). A review of rural traffic counting methods in developing countries. TRRL Laboratory Report 427. Crowthorne: TRL Limited

Standard Vehicle Classification Chart

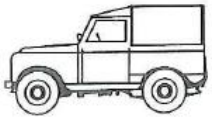
Category	***Type of Vehicle***	***Description***
1 ***Light vehicles***		
1a	Motorcycles etc.	Motorcycles (with or without side-cars, e.g. motor tricycles).
1b	Passenger cars	Includes passenger cars seating no more than nine persons, estate cars, hire cars and taxis.
1c	Small buses	Includes minibuses, jeepneys, matatus, etc. Usually less than 40 seats.
1d	Light goods	
2 ***Medium and heavy vehicles***		
2a	Large buses	All regular large passenger vehicles and coaches. This category does not include minibuses, jeepneys, matatus, etc. Usually more than 40 seats.
2b	Medium goods	2-axled vehicles with twin tyres on rear axle, more than 1.5 tonnes unladen weight but not exceeding 8.5 tonnes gross vehicle weight.
2c	Heavy goods (3 axles)	Larger trucks with three axles.
2d	Heavy goods (4 or more axles)	Vehicles with four or more axles (trailers being included as part of the vehicle) or exceeding 8.5 tonnes gross vehicle weight. Heavy vehicles may also be defined as those with an unladen weight of 3.0 tonnes or more.
3 ***Others***		
		Includes miscellaneous vehicles such as tractors, road rollers, etc. Many different types of vehicle could be recorded here. The type will depend upon factors including the purpose of the survey, the transport modes widely used in a particular country and the survey location. For example: i) for roads with high flows of multi-axled commercial vehicles, trucks with five or more axles and trucks with trailers could all be identified separately; ii) rickshaws, bicycles or tricycles could be recorded since large flows can be important when designing road width and geometry.

Source: ORN 40 (TRL, 2004)

Vehicle Classification Examples

CARS

LIGHT GOODS

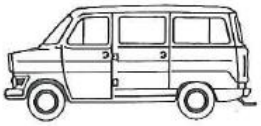


Land Rover

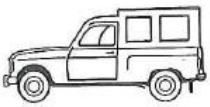
Range Rover

Pickup

Van

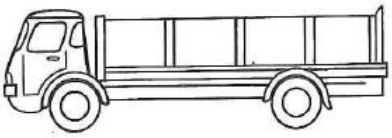


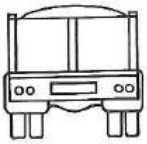
Transit/Minibus

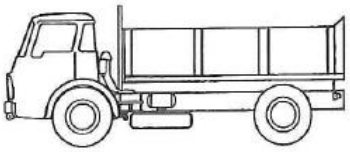


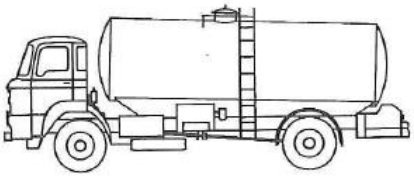
Matatu

MEDIUM GOODS
2 axle trucks with 4 rear tyres

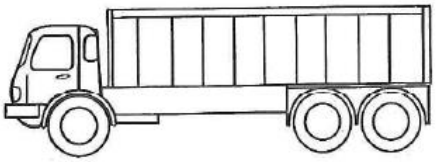


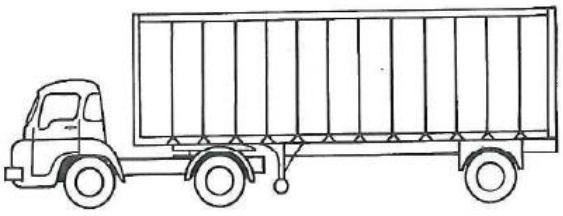




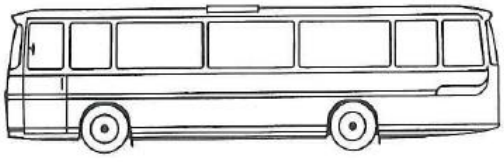


HEAVY GOODS
more than 2 axles





BUS



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Sample Traffic Count Survey Form

Site number	Site location	Direction	Day	Date

Name	Day/Night

Vehicle class	6.30–7	7–8	8–9	9–10	10–11	noon m/n 11–12	noon m/n 12–1	1–2	2–3	3–4	4–5	5–6	6–6.30	Totals
Cars														
Light goods landrover van/pick-up matatu minibus 'medium' bus														
Medium goods (2 axles)														
Heavy goods														
Buses														
Totals														
Others														

Sample Origin-Destination Survey Form

Site No. ..... Date.....

1 Time ..... 2 Registration number.....

3 Vehicle type

Car	☐	1	Used as a Matatu or Taxi?	Yes ☐
Landrover	☐	2		No ☐
Pickup/Van/Minibus	☐	3		
'Medium' Bus	☐	4		
Large Bus	☐	5		
Medium Goods	☐	6		
Heavy Goods	☐	7	How many axles?	
Other	☐	8	Specify	

O Code ☐☐

4 Where did you start this journey? .....

At what time? .....

Have you stopped on the way? Yes ☐ Where? ..... Why? ..... No ☐

D Code ☐☐

5 Where will you finish this journey? .....

At what time? .....

Will you stop on the way? Yes ☐ Where? ..... Why? ..... No ☐

Intermediate stop

Yes	☐
No	☐

6 What is this vehicle being used for?

To carry passengers	☐	1	Number of passengers .....
To carry goods	☐	2	Empty ☐ Loaded ☐
			Type of goods .....

Load Code ☐☐

7 Why are you travelling?

Business	☐	1
Tourism	☐	2
Social/Personal	☐	3

Remarks

Notes for Conducting Origin-Destination Survey Driver Interviewing
(to accompany O-D survey form)

1. These notes are intended to help you in the classifying of traffic and in the conducting of interviews with drivers stopped for questioning. They are meant to be read in conjunction with the origin-destination survey interview form to be used in the particular survey.
2. The first thing to be entered on each form is the code specifying in the interview site location. Each site will have an O-D number which is inserted on the space Site Number. This should be done in advance of the actual interviews at the start of each day or at periods when no vehicles are stopped.
3. At the same time as the site location is being filled in, the date (including the day) should be inserted.
4. When the driver of a vehicle is about to be interviewed the time of interview should be inserted.
5. As the vehicle to be interviewed is approaching or slowing down the registration number should be recorded together with a tick in the box opposite its appropriate classification type (e.g. car, bus, etc.). The actual classification of vehicles will be as shown on the interview sheet i.e.:-
   i. Car
   ii. Land rover
   iii. Pickup/Van/Minibus
   iv. 'Medium' bus
   v. Large bus
   vi. Medium truck
   vii. Heavy truck
   viii. Other

i. Car
This class includes passenger road motor vehicles seating not more than 9 persons (including the driver). Station wagons are included, but not 'Land rover' or 'Range Rover' type vehicles.

ii. Land rover
This includes range rovers and land cruisers as well as land rovers but not transit vans. Generally these will be 4-wheel drive vehicles.

iii. Pickup/Van/Minibuses
Goods vehicles of less than 3000kgms (3 tonnes) gross vehicle weight. Transit vans are included in this class. A minibus seats approximately 12-15 passenagers.

iv. 'Medium' bus
This is a medium sized bus, larger than a minibus but smaller than the large bus. It can seat approximately 25 passengers.

v. Bus
This class should include buses which are purpose built to carry passengers. These would generally seat more than 25 passengers.

vi. Medium Truck
This class should include all 2-axled goods vehicles of 3000kgms (3 tonnes) or more gross vehicle weight. A simple means of recognising this class is that it consists of all 2-axled goods vehicles whose rear axle has more than 2 tyres.

vii. Heavy Truck
All goods vehicles of more than 2 axles. The number of axles of the vehicle should be put in the box provided.

viii. Other
Make a note on the interview form of any other vehicles (tractors, mobile cranes, graders etc.) but do not attempt to interview them.

6. If the vehicle is one of the first three types (car, land rover, pickup, van, minibus) we need to know if the vehicle is being used as a matatu. Tick either Yes or No.

7. The next questions on the interview form are concerned with the origin and destination of the vehicles' journey or trip. They are important questions and great care should be taken in asking them and recording the answers. Before the survey begins you should familiarise yourself with a map of the area and memorise the principal towns and villages.

8. The first question asks for the origin of the vehicles' journeys on the day of the interview. If you do not recognise the village or town ask the driver where the place is near and enter this on the form as well.

9. The next question asks what time he started his journey.

10. Next we wish to know if the vehicle has stopped on the way. In the case of buses and matatus the answer is generally, but not always, Yes. For the other vehicles classes we are concerned with deliberate stops, usually in connection with business, not temporary halts for petrol, meals refreshments etc. These we will not classify as stops for journey purposes. If the vehicle has made a number of stops we will want to know where the last stop was. If the vehicle has stopped we wish to know the reason for stopping. It will not be necessary to put the question 'why?' to bus or matatu drivers.

11. Similar questions are then asked regarding the destination of the journey and whether the vehicle will stop on the way. If the vehicle intends stopping several times then we wish to know where the first stop after the interview will be.

12. The next question asks what the vehicle is being used for. We want to know the main use of the vehicle on this journey, whether it is for carrying passengers of for carrying goods. Tick the appropriate box. If the vehicle is being used equally for passengers and goods then both boxes should be ticked. Then if the 'passenger' box is ticked, record whether the vehicle is empty or loaded. If loaded then record the type of goods being carried.

13. The next question asks the reason for travelling. One of the three boxes should be ticked. For goods vehicles, buses and matatus the answer will usually be business.

14. In the remarks space enter any comment about the vehicle, its occupants, or its load that is peculiar or that you think worth mentioning. For example, if a driver refuses to answer all or some of your questions, make a note of this. If a vehicle does not stop when required, note the vehicle type.