Session 6.4: Trainee Notes

Traffic Counts, Origin-Destination Surveys and other Approaches

Contents

Learning Objective

After completing this session, you will:

- Understand why traffic surveys can be important in transport research
- Understand the principles of undertaking manual classified traffic counts
- Know what an origin-destination survey is and what information it will provide
- Be familiar with the rapid assessment of rural transport services methodology involving an appreciation of transport corridors, hubs and spokes
- Know about the latest research in developing appropriate rural transport service indicators based on the rapid assessment method using hub and spoke patterns of transport services

1. Why do we need traffic surveys?

Basic traffic data is needed in order to make important decisions on

1. Investment
2. Planning
3. Design and Construction
4. Operation
5. Maintenance

These important decisions cannot be made effectively unless we fully understand:

- The road system
- How traffic uses the system

Traffic counts are some of the most important planning data and can be used for:

- Network appraisal - the ADT represents the most important criteria in determining priorities for expenditure between different roads in a road network. In the majority of cases the importance of a road can be judged by the volume of traffic using it.

- National transport planning - traffic count data can be used in forecasting fuel consumption, the effects of fuel price changes, the consequences of pollution and the estimation of other variables such as trends in annual kilometres driven.

- Social trends statistics - changes in traffic levels can provide a good indicator as to the level of economic growth in an area. Gender disaggregation will also provide a social profile of different modes of travel.

2. Traffic Counting

Traffic counts are conducted to record the level of use of a road, as well as to classify the vehicles by type, and to estimate vehicle occupancies (i.e. the average numbers of passengers carried by each vehicle type).

Classification is particularly used to highlight the amount of heavy goods vehicles (HGVs), and is used in association with axle-load surveys to indicate both the design requirements and the amount of damage being inflicted on the road pavement.

Traffic counting can be undertaken manually, or more conveniently by automatic traffic counters. The latter can record and store information for long periods, before being read. Modern counters record information in electronic format that can be downloaded straight into customised traffic analysis software. However, many of the automatic traffic counters currently available are not well suited to use in rural areas.

Automatic counters are also capable of recording vehicle classifications, although the accuracy is generally poor. Vehicle occupancy counts must be undertaken manually.

The main output from a traffic count is a measure of average traffic flow, recorded as the total traffic passing in both directions over a 24 hour period (the Average Annual Daily Traffic or AADT). For low volume roads the variability in traffic flow from day to day can be very high, and short counting periods can introduce high errors in estimates.

The types of traffic volume measurement are as follows:

Average Daily Traffic (AADT)

- AADT is the average of 24-hour counts collected over a number of days, but less than a year.
- AADT may be used for planning of highway activities, measurement of current demand and evaluation of existing traffic flow.

Average Annual Weekday Traffic (AAWT)

- AAWT is the average 24 hour traffic volume occurring on weekdays over a full year.

Average Weekday Traffic (AWT)

- AWT is the average 24 hour traffic volume occurring on weekdays, based on traffic counts for some period of time less than one year.

Peak Hour Volume (PHV)

- PHV is the maximum number of vehicles that pass a point on a highway during a period of 60 consecutive minutes.
- PHVs are used for functional classification on highways, geometric design, traffic operations and management.

Peak Hour Factor (PHF)

- PHF is a measure of variation in demand during the peak hour.
- Defined as the ratio between peak hour volume and peak rate of flow (PRF): PHF = PHV/PRF
- For 15 minute period of flow, the equation becomes: PHF = PHV/ $(4*V_{15})$
- The normal range of PHF is 0.70 to 0.98
- Lower values signify a greater degree of variation in flow during the peak hour.

Design Hour Volume (DHV)

- Transportation links are designed neither for average volume nor for the maximum volume of traffic.
- The peak hour volume that is used in design is termed as Design Hour Volume.
- The 30^{th} highest peak hour is used for the design of many rural highways.
- A design hour in the range of 10^{th} to 20^{th} highest peak hour is chosen for urban facilities.

Variability of traffic due to seasonality (with the possibility of impassability in the rainy season), may be important. Adjustment factors for seasonal variation are usually difficult to estimate with any degree of accuracy.

The accuracy of traffic counts is improved as the count duration increases, when the count is undertaken in more than one period of the year and on roads with higher traffic volumes. Improved accuracy can also be achieved by using local knowledge to determine whether there are days within the week or periods during the year when the flow of traffic is particularly high or low. Counting on these "exceptional days" can have a significant impact on accuracy. Factors to look for include:

- Market days
- Religious days
- People travelling to and from urban areas for the weekend
- Wet weather affecting road traffickability and desire to travel
- Increased traffic flows during harvest seasons
- National holidays
- Local holidays
- Strike days
- Closed borders

Traffic counts on low volume rural roads should also include pedestrians, bicycles and other types of non-motorised means of transport (NMTs), and where possible be disaggregated by gender for drivers and passengers. Local knowledge should also be used to pick appropriate locations for conducting the traffic counts to ensure a true reflection of the traffic using the road to avoid under or over counting. Factors to look for include:

- Avoid counting too close to towns and villages
- Be aware of the location of junctions and the impact of these on traffic flows
- Pedestrians and NMTs may use local footpaths and tracks in addition to the road.
- When counting this type of traffic ensure that the count station is located to capture all traffic
- Rural people predominantly travel as the sun is rising and as the sun is setting
- When counting in the wet season have knowledge of local diversions on poor roads

On low volume roads it is particularly important to count non-conventional means of transport. These include pedestrians, bicycles, animal transport, motorcycles, tractors and trailers and other simple motorised technology. On low volume roads these types of transport can account for the majority, or at least a significant proportion, of the total transport burden.

3. Origin-Destination Surveys

In a number of situations the knowledge of volume counts at various locations is not sufficient. Often knowledge of where the vehicles are coming from, and where they are going, is vital for analysis purposes. An Origin-Destination (O-D) study is performed to determine traffic patterns on a typical day. This data is used in many ways by planners & engineers

to help in short, medium and long-range planning. Therefore, the main aim of an O-D survey is to establish the travel pattern in a study area. The travel pattern is documented by preparing the O-D matrices, the cells of which give the number of trips made between pairs of traffic zones:

- II – Internal Internal
- External External
- EI – External Internal
- IE – Internal External
- T – Through Movements

O-D survey information is very useful for short term traffic engineering applications such as i) obtaining traffic pattern information for planning alternate route studies, the most common of which is the bypass study, ii) management of traffic at major activity centres, and iii) planning for interchanges and elevated roads.

Study Area and its Delineation

Before carrying out any O-D survey one needs to define the study area, delineate the area by defining the traffic analysis zones, cordon lines and screen lines. These terms are defined here.

External Cordon:
The boundary of the study area is referred to as the external cordon. Four main criteria are used to define the location of the external cordon; namely:

a) It should include those areas which are related in terms of the average daily travel forming a commuting catchment of the central business district (CBD). Where the city or town, or the focus of the study is free-standing, defining this boundary is relatively simple. In the case of large urban areas, where the focus area is only a part of it, defining the study area boundary can be far more difficult.
b) It should also include those areas that are expected to become part of the "commuter catchment" within the time horizon for which the study is being done.
c) It should be located where the number of transport routes crossing the cordon can be minimised.
d) The study area boundary should conform with the boundaries already established for administrative purposes, for instance district borders

Traffic Zones:
The study area is divided into traffic zones. The boundaries of these zones should be selected to include areas with homogenous land uses and trip making characteristics. For convenience the boundaries of traffic zones should follow the already established ward/census section boundaries.

Cordon lines and screen lines:
In addition to the external cordon the study area may have one or more internal cordon lines enclosing the areas of intense activity (e.g. CBD or areas of special interest). Cordon stations are established wherever the cordon line intersects the transport links feeding into the area. Roadside

interviews are conducted at these stations to find out the origin and destination of the trips and other details of interest. In addition continuous volume counts are also made at these locations. Screen lines are imaginary lines drawn along natural/artificial boundaries (e.g. river or railway line) dividing the study area into large natural zones with few transport links crossing them. The traffic count stations are established at these few crossings and this data is used in validating the travel pattern obtained from home interview surveys and roadside O-D surveys.

External and Internal Trips

The travel pattern in a study area is a result of four types of movements, namely: external to external movements, external to internal movements, internal to external movements, internal to internal movements and through movements. Figure 1 shows these types of movements.

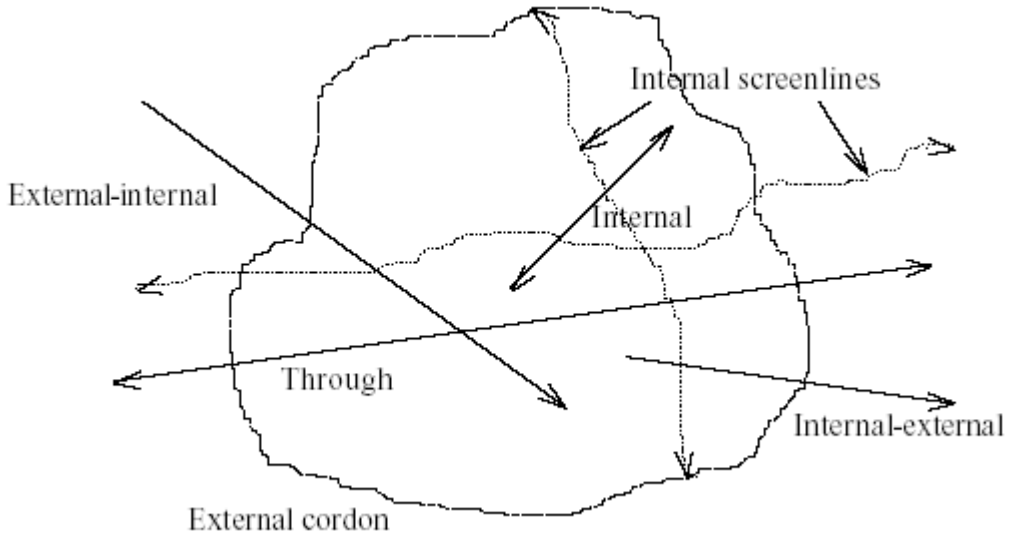

Figure 1: Types of Movements

Details of these movements and the source from which they are obtained are given here.

a) **Through movements:** these are external-external movements, in which both the origin and destination of each movement are outside the study area. These movements are usually recorded through traffic studies where transport corridors cross the external cordon.
b) **External-internal movements:** where the origin is outside and the destination is inside the study area. These movements are usually recorded through traffic studies where transport corridors cross the external cordon.
c) **Internal-external movements:** where the origin is inside and the destination is outside the study area. These movements are usually recorded using home interviews, and checked against volumes collected at external cordon surveys.

d) **Internal movements:** where the origin and destination of the trip are both inside the study area. These movements are usually recorded using home interviews and checked against volumes collected at internal screen lines.

Thus the home interview survey is necessary to establish the travel pattern relating to the trips made within the study area (i.e. internal movements). The other components of the O-D matrix, the external to external and external to internal trips, are obtained mainly by the roadside O-D surveys at cordon stations. Roadside O-D surveys can be done by roadside interview method, the license plate method and the tag on vehicle method (where a GPS tag is attached to the vehicle to capture journeys).

Home Interview Survey

In this method trained personnel visit a selected sample of households and interview all the members of the family to get the desired data. This method of collecting data is called the face-to-face interview method. Alternatively, one can use the drop-and-pick-up method in which the questionnaire is given to the households and collected the following day. However, the response rate of the latter has been found to be unsatisfactory, especially in cities of the developing world. The design of the questionnaire form is of great importance to the success of the survey. Questions should always be objective in style, clear and unambiguous. In a home interview survey data on three broad items are collected.

Household Information: The information on household characteristics includes household size, dwelling unit type, vehicle ownership, family income, etc.

Person Information: The data on socioeconomic characteristics of individual members of the household, such as relation to head of household, age, sex, occupation, income, possession of driving license, etc. are collected.

Trip Information: The residents are generally asked to describe their movements on the previous day (a typical working day). Data are collected on the origin of the trip, destination of the trip, trip purpose, land use at origin and destination, mode used, travel time, waiting time, travel cost, etc.

Home interview surveys comprising travel diaries and a household questionnaire are also covered by this course in Session 6.2: Quantitative Research Methods.

Survey Data Coding

During the survey on site, the supervisors must check the data for coherence and completeness. After this step the survey data have to be transformed into a format suitable for electronic data processing.

Therefore each piece of information is assigned a numeric code or alphanumeric code. The coded data is then punched and checked for errors. The valid ranges for all the variables and in general the internal consistency of the data is checked during this process.

Roadside Interview Method

This method mainly aims to obtain the information regarding the internal to external, external to internal and external to external trips. As all the information is collected directly from the drivers of the vehicles, this method is capable of supplying detailed and accurate information. The survey points are selected along the junction of the cordon line or screen line with the roads. The cordons may be in the form of circular rings, radial lines or rectangular grids.

Requirements of Interview Site

The interview site should be selected in such a way that both the person interviewing and the motorist are safe. A minimum of 80-100 m of unrestricted sight distance should be available on both sides and well clear from the intersections. Signs explaining the purpose and extent of stoppage should be located well in advance of each site.

Interview Personnel and Procedure

There should be a minimum of two people for conducting roadside interviews in each direction, in which one will be taking the classified vehicle count in the direction being studied, and the other will be conducting the actual survey. On a fairly busy two-lane road, the interview team should consist of a party chief, two recorders, six interviewers and two policemen.

For complete and reliable data the questionnaire should be framed and designed with care and the interviewers should be given adequate training. The hand out for Session 6.4 gives a typical field datasheet for the roadside interview method. The questionnaire contains the following details to be filled:

- Type of vehicle
- Vehicle occupancy
- Origin and Destination of the trip
- Purpose of the trip
- Parking location
- Intermediate stop
- Time period
- Route followed

When collecting O-D data by this method it is desirable to exclude scheduled buses from any interview. They should be recorded in the classification count. The interviewers should have policemen to help control and direct the traffic. A 24 hour count will not normally be needed, and the survey is often restricted to 12 hours (0700-1900 Hrs) to 16

hours (0600-2200 Hrs). The vehicular count survey will be carried out for the whole 24 hours. To avoid any sort of bias in the data collected, the roadside interview should be conducted for each weekday (Monday-Friday).

Sampling

As it is not possible to stop each and every vehicle and get the required information, sampling procedures are normally adopted. Sampling is necessary to avoid traffic delays or else the local traffic will detour about the interview site, distorting the traffic pattern. A stratified sampling technique is used to get the representative sample from each vehicle class. In general, the survey is administered to at least 25% of the traffic for roads with an AADT under 10,000 and at least 10% for those over 10,000. For roads where the traffic volume is over 18,000, lower sample rates may be allowed.

4. Rural Transport Hubs and Spoke Model

(source: Starkey, 2007)

Background to study

Rural transport services are often inadequate. Passenger and goods transport needs improving to stimulate rural economies and reduce poverty. Understanding existing rural transport systems and any constraining factors is a precondition for appropriate policy action.

The Sub-Saharan Africa Transport Policy Program (SSATP) commissioned a study to develop and test a methodology for the rapid assessment of rural transport systems. The guidelines specified passenger and freight transport for distances of 5-200 km, encompassing much rural transport, but excluding within-village transport, long-distance national transport and international corridors. Four national experts and the team leader implemented the methodology in parts of Burkina Faso, Cameroon, Tanzania and Zambia.

Methodology

Rural transport systems operate on hub and spoke systems at several levels. Key rural hubs are provincial/regional towns, market/district towns and villages. Spokes have catchment populations using them to access markets or services. The various spokes and hubs have characteristic combinations of transport, including trucks, buses, minibuses, pickups and intermediate means of transport (IMTs). The smallest spokes are footpaths while national spokes form transport corridors. The methodology surveys transport types, operators, users and regulators at sampled hubs and spokes, stratified by hub hierarchy and remoteness. This provides a rapid overview of rural transport systems, highlighting key constraints, stakeholder views and proposals for improvements.

A region, representing about 5 percent of the country, is chosen where the transport catchment area corresponds approximately to administrative boundaries. Within this area, open-ended interviews are held with the regulatory authorities (local government, police) at provincial, district and village levels. Operators, suppliers and repairers of transport devices (motorized and non-motorized) are interviewed and operating costs and fares recorded. Interviews are conducted with users (and potential users) of transport including farmers, traders, employees, household managers, school authorities, pupils, health service providers, patients and marginalized people. Traffic counts (including pedestrians and IMTs) are carried out on selected provincial, market and village spokes on market and non-market days. All data acquired is geo-referenced by taking global positioning system (GPS) coordinates.

During the survey, observations, data and stakeholder opinions are reviewed on a daily basis. Information is specifically triangulated by comparing information from different sources and anomalies are investigated immediately. Survey guidelines stress the importance of poverty focus and crosscutting gender, safety and HIV/AIDS issues. Complementary national level document reviews and interviews ascertain the positions of key institutional stakeholders, the policy and regulatory frameworks, and the availability of relevant data.

Implementation, reporting and follow-up

The participative methodology requires two months to implement (including planning and reporting). One transport professional, or a small team of experts, undertakes all the semi-structured ('rapid rural appraisal') interviews. Enumerators are not employed for interviews.

The information collected should lead to estimates of the regional fleet of motorized and non-motorized vehicles, and the traffic characteristics of the sampled spokes. Tables of passenger and freight costs for different transport means and road types can be compiled. Many results can be presented in graphical form, including public transport routes and areas without access to motorized transport. Computer-generated maps can be used as models in subsequent planning. The surveys should provide a composite picture of the existing rural transport situation with some clear examples of the opportunities and constraints facing transport operators and the different categories of users, potential users and non-users.

Rural Transport Service Indicators

(source: Starkey, 2013)

The rapid assessment method using hub and spoke patterns of transport services is currently being used in an AFCAP funded research study being undertaken by IFRTD and Paul Starkey which aims to identify, develop, test and share rural transport services indicators to assess how good rural transport services are at providing access for rural people.

The aim of the research is to identify and test indicators that can 'measure' rural transport services in valid ways that are meaningful to the key stakeholders. The rural transport services indicators developed should be consistent, replicable and be sensitive to changes in the transport services. They should allow appropriate comparisons over time and space. They should be based on data that are easy to collect and should measure parameters that are relevant to the main stakeholders (passengers, operators, regulators) and which could be improved by appropriate actions.

Key indicator components may include actual passenger fares, frequency and journey time. If practicable, they should also reflect safety, security, reliability, predictability, accessibility and comfort, taking into account issues concerning gender, age, disability and socio-economic disadvantage. Other issues may include transport capacity, freight transport and the integration of alternative modes of transport.
Initially rural transport service indicators will relate to individual roads. Subsequently they may be aggregated to develop indicators for wider areas such as districts. Road-specific indicators are appropriate because each road has unique transport services characteristics. Furthermore, road specific transport services indicators could be used by those concerned with road management to justify, monitor and evaluate road investment and maintenance.

The survey methodology for obtaining the information on rural transport services draws upon the World Bank publication on the rapid assessment of rural transport services (Starkey, 2007). This includes an assessment of the local hub and spoke patterns of the transport services in the area, and includes the concept of the transport 'catchment population' of a road. The methodology is intended to be implemented by transport professionals (not enumerators) who will rapidly build up a detailed understanding of the issues. To obtain a broad understanding, operators, regulators and passengers will be interviewed, with specific categories of users targeted, including disadvantaged groups. At least 40% of passengers interviewed should be women, and the data are disaggregated for gender.

In addition to quantitative and qualitative questions to the various stakeholders, the survey requires observations of transport service operations. This facilitates understanding of how the actual transport operations are affecting the various stakeholders, including those who are effectively excluded due to problems of access, cost, safety or service quality.

The methodology also involves triangulation at the time of the interviews. Information from the various sources (operators, regulators, passengers of different types, observations of actual practices) are continually compared. Any discrepancies are immediately highlighted and probed while the researchers are still undertaking interviews. As a result, a picture is built up of the real situation, with an agreed consensus of the actual transport costs, frequencies and capacities as well as the strengths and weakness of the services provided.

Spatial data on rural roads and infrastructure related to rural transport services are obtained using geographical information systems (GIS) tools. Where road GIS data are not available, these can be obtained by using simple global positioning system (GPS) handsets to record tracks. Key nodes and facilities are identified during the survey as waypoints to capture their geo-coordinates using the Universal Transverse Mercator (UTM) system to ensure compatibility with other existing data sets such as Google earth.

The survey methodology for obtaining information to develop rural transport service indicators draws on the rapid assessment hub and spoke model. The aim is to collect reliable and repeatable data sets from Kenya, Tanzania and Cameroon that can be used to develop indicators which are acceptable to users, operators and regulators.

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