

New York Port Authority's 1958 O-D Survey Using Continuous Sampling

WARREN B. LOVEJOY, Transportation Economist, The Port of New York Authority

●THE PORT OF NEW YORK AUTHORITY in 1958 adopted a continuous sampling method of conducting roadside O-D surveys. Previously, so-called "one shot" surveys in which one to three days of traffic were surveyed as representative of an entire year's traffic had been employed. The thinking behind this new method and the technique employed are reviewed and a resumé of the 1958 Survey results is given.

Briefly, this new technique is based on a carefully designed and controlled probability sample which builds up the interviews obtained to the required number for any desired degree of reliability by sampling over a considerable length of time rather than by sampling heavily in a short period of several days. Thus, by obtaining a few hundred interviews each day, a total of 93,329 interviews were accumulated over the course of the year 1958. These interviews were obtained under all of the varying conditions which existed in the field throughout the year.

ADVANTAGES OF CONTINUOUS SAMPLING

There are a number of advantages to be derived from the use of this new traffic survey technique. Among the more important of these, as they apply to the Port Authority's O-D survey problem, are the following:

1. By spreading the sampling over a long period of time, this system avoids the possibility inherent in "one shot" surveys that seasonal or other variations might make traffic unrepresentative on the day or days surveyed. In continuous sampling, a sufficient variety of traffic patterns over the days and seasons are covered so that the survey results are representative of normal traffic patterns. By the same token, spreading the interviews in this way makes it possible to measure seasonal variations.
2. This new technique provides up-to-date information on O-D patterns at all times because the survey data is continuously being obtained and can be analyzed periodically. This has already been useful in analyzing traffic developments in the light of weather variations, recession and construction of new facilities.
3. Building the size of the sample over a long period, rather than by intensive sampling during one day or several days, has eliminated the necessity of hiring large numbers of unskilled, temporary employees as interviewers and coders. For the continuous sampling, four regularly employed interviewers did all of the interviewing as well as the coding. These men were trained in interviewing methods, had a thorough knowledge of the geography of the Metropolitan Area, and were skilled in the coding of the data.
4. Because continuous sampling avoids intensive sampling at any facility at any one time, there is little chance of causing congestion at the facilities while obtaining the O-D information. Furthermore, skilled interviewers greatly reduce the time required for each interview and are thus able to get complete information on each interview without undue delay to the motorist.
5. By using a probability sample, it is possible to compute mathematically the degree of reliability achieved by the survey and thus keep a constant check of the accuracy of the results.

The design of the sample is as follows:

1. The sample was a probability sample requiring that every vehicle trip made during the year over the Port Authority tunnels and bridges have a known probability of selection. This was achieved by a randomized selection procedure at every stage of the sample design.
2. The level of reliability required in the survey specified that with the expected

over-all sample size of from 90 to 100 thousand interviews, a sample estimate of 1 percent, or 1,000 interviews, would have a coefficient of variation (maximum margin of error) of the order of 3 to 6 percent.

3. There was built into the sample design a procedure for developing proper measurements of the standard errors of the various sample estimates.

DEVELOPMENT OF GENERAL SAMPLE DESIGN

The general sample design had to be such that all of these statistical requirements for a probability sample were met, but it also had to be able to accommodate the practical problems encountered in the actual conduct of the survey. These two considerations necessitated development of a number of procedures, as follows:

1. The survey budget permitted the assignment of four permanent field survey interviewers to this project. These interviewers were responsible for both the field work and the office work in connection with this survey. Because this was the limit of the manpower available, it was determined that the field work had to be restricted to eleven tours of duty per week.

2. Reasonable working hours and the necessity of minimizing fluctuations in hourly traffic volumes within shifts were used as the criteria in designating the hours for shifts which became the primary sampling units. The shifts were set up as 8-hr periods to be spent at one facility on any one of the seven days of the week. The hours of the shifts decided upon were 11 p. m. to 7 a. m., 7 a. m. to 3 p. m. and 3 p. m. to 11 p. m.

3. To insure good coverage of O-D patterns, directional flows, vehicle types and vehicular volumes at each facility during each 8-hr period, the interviewer moves from one lane to another each hour in a prescribed pattern of rotation. The design includes specified relief periods each hour, but it is assumed, with good reason, that the traffic patterns during these relief periods are not different from those sampled during the interviewing periods.

4. Because of the distances involved in covering the entire toll plaza of a facility, it was necessary to subdivide each facility into two or more locations. The locations were selected in such a manner as to allow interviewers to enumerate the number of lanes open within a location in each hour. The interviewer rotates among the lanes at one specified location for 4 hr and then moves on to another location.

5. Experience with previous "one shot" surveys supplemented by field testing indicated that an average work load of 40 interviews per hour could be achieved by the interviewers. This does not mean that in busy periods more than 40 interviews per hour could not be secured. It does mean that throughout the conduct of the survey an average rate of about 40 interviews per hour was achievable.

6. A knowledge of hourly traffic variations via each facility on the different days of the week was utilized in selecting uniform sampling rates during each shift that would allow for reasonable work loads for the interviewers. The possibility of selecting any shift at any facility was proportionate to the amount of traffic volume expected to occur during the shift.

7. To assure a self-weighting sample, a procedure of balancing actual interviews against expected interviews was introduced. Thus, interviews could be duplicated or omitted depending on such factors as the ratio of actual to expected lanes open, loss of interviewing time due to bad weather and non-response.

1958 SURVEY RESULTS

Much of the data obtained in the survey is of interest only to those concerned with traffic in the New York-New Jersey Metropolitan Area. However, the following material is of general interest particularly as it shows what can be accomplished by this type of survey:

1. More than 83 percent of the trips over the Port Authority bridges and tunnels are made entirely within the 18-County Metropolitan Area. Nearly 14 percent have either origin or destination in the bi-state Port District and only 3 percent are through-trips with neither origin nor destination in the District.

2. Trends in O-D patterns since 1949 emphasize the importance of providing future peripheral facilities and routes both for autos and trucks. Traffic growth was most pronounced in the outlying counties of the Port District whereas the Manhattan Central Business District (Manhattan south of 59th Street), decreased sharply as a traffic generator from 39.3 percent of total trans-Hudson vehicular origins and destinations in 1949 to 33.9 percent in 1958.

3. As might be expected, weekday patterns are considerably different than Sunday patterns. Peripheral traffic (that is, vehicles with neither origin nor destination in Manhattan or Hudson County) constituted 53 percent of weekday trans-Hudson traffic as compared with 69 percent on Sundays.

4. Seasonal analysis shows a pronounced shift in traffic during the summer months away from the core areas toward the periphery. As might be expected, the largest seasonal variations were observed in traffic to and from the resort areas located in Union County and south. Furthermore the seasonal variations in these areas are large enough to have a definite effect on peak traffic loads.

5. The hourly and directional analyses made possible by this type of survey clearly indicate that wide differences in O-D patterns exist between averages for an entire weekday or Sunday and patterns which occur during peak periods in each direction. For instance, the Manhattan CBD, where 32 percent of trans-Hudson autos originated or terminated their trips on an average weekday in 1958, accounted for 39 percent of the eastbound traffic from 7 to 10 a. m., but only 17.5 percent of the westbound volume during those hours. In the afternoon peak hours, 4 to 7 p. m., the Manhattan CBD accounted for 39 percent of the westbound traffic and 24 percent of the eastbound volume. Here is a definite indication that the subject of reversible approach lanes is certainly well worth investigating.

6. Only 47 percent of the trans-Hudson auto trips during 1958 were made for business purposes, 51 percent for recreation and personal reasons and a surprisingly low 2 percent for shopping. During morning peak periods on weekdays, however, 86 percent of the trips were for business purposes. This proportion dropped in the afternoon peak periods to 68 percent for eastbound traffic and 72 percent for westbound traffic.

7. There has always been a heavy reverse flow volume eastbound into New York City from 4 to 7 p. m. By combining hourly purpose and hourly license plate analyses, it was shown that this heavy volume was composed of the normal flow of New Yorkers returning home from work in New Jersey plus a large number of New Jersey residents driving into New York City for pleasure purposes.

8. The average number of persons per trans-Hudson auto during the peak hours eastbound in the morning and westbound in the afternoon tends to be somewhat lower than the non-rush loads. Car pooling is not a large factor in this movement to date probably because the bulk of this commuting is still done by common carrier. Just the opposite is true, however, for the "blue-collar" workers commuting to New Jersey industrial locations, who obviously make much greater use of car pooling.

To sum up, it is felt that this new method of continuous sampling in O-D work has been successful, and it is planned to continue its use in the future. Statistically, it is found that the level of reliability in the survey results has been high and one of the reasons for this is the use of skilled rather than non-skilled interviewers. The survey has given much better seasonal, hourly and supplemental information than obtained previously, and this information has been and will be kept current in the future. The cost of the survey for the year was considerably less than the cost of conducting a "one-shot" survey. Finally, this method gives great flexibility in the types of information obtained from the survey. For instance, the Port of New York Authority has been experimenting with obtaining routing information to supplement its knowledge of origins and destination. Also, in the 1960 Survey peak periods are being concentrated on in order to obtain more detailed and accurate information concerning peak traffic flows which are so important in the analysis of demand versus capacity considerations.