

Estimating Small-Area Public Transit Use by Direct Survey

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Projecting ridership for a new transit service requires market research to establish the probable level of demand and the proper fare and service frequency. To assess the market for proposed bus services in Northern Virginia, a survey was conducted of all households in the proposed service areas. Questions asked on the survey were designed to permit analysis using a screening process to determine if the respondent was a probable transit user. The screening was based on work trip characteristics (e.g., work hours, work place, proximity to Metrorail) and worker characteristics (e.g., need to pick up or drop off children). For the one bus service initiated since completion of the analysis, ridership is quite close to that obtained from the screening process.

Should a new bus service be instituted? How frequently should service operate? What fares should be charged? These questions are faced by transit operators on a day-to-day basis. Many techniques have been applied to provide answers. Some of the techniques used to estimate patronage and hence costs and revenues for new services include

- Subjective evaluation based on comparison with similar existing services,
- Application of specially designed short-term forecasting models (1-3), and
- Application of regional travel demand models.

Each of these approaches has limitations that suggest the need for alternative procedures. When applied by an experienced practitioner, subjective evaluation can yield reasonable results; however, no two cases are ever exactly comparable, and slight variations in demographic or work location characteristics can lead to large variations in transit use. Two neighborhoods may look the same, but if one has a higher concentration of CBD workers, the transit use patterns may be quite different.

Specially designed short-term models can also yield quite good results (4) but are only an option if a previously developed, calibrated, and tested model is available. Developing a model for route level patronage forecasting requires gathering travel pattern and demographic data at a level of fine geographic detail, describing the quality of transit services at the same level of detail, and then using statistical techniques to fit a relationship. Even when a good overall fit is obtained, there

will be cases for which the estimate has substantial error. This will not be due to any defect in the model but rather is inherent in any statistical procedure. Thus for any specific route or service proposal, the patronage estimate could have a large probable error.

Regional travel demand models typically do not offer adequate precision to provide useful estimates of transit patronage on a small scale, for example, a single route serving a specific neighborhood.

Stopher et al. (5) present a method for using regional-level simulation data for route level planning. The method involves a specially written computer program and requires that networks meet certain specific requirements, providing greater detail than typically found in regional models. Even so, there ". . . will remain a need for a significant level of professional judgment to be applied to the final result." Given the level of effort necessary to prepare regional networks and travel models, a regional approach could be desirable if many route and service options are to be explored. For detailed analysis of only a few options, the analysis effort would not be compatible with the risk.

Two communities in Northern Virginia were faced with the problem of estimating transit use for proposed new bus services. The opening of the final segment of Washington, D.C.'s Metrorail Orange Line provided a high level of line haul services to many communities, but park-and-ride facilities are already filled to capacity. Greater use of feeder bus services will be required to achieve maximum benefit from the rail service. The study described in this paper estimated the demand for feeder bus services in two Northern Virginia suburban communities, the city of Falls Church and Centreville in Fairfax County. The two communities joined with the Northern Virginia Transportation Commission (NVTC) to engage a consultant to estimate demand within well-defined areas and to develop techniques that could be readily applied throughout the region.

STUDY APPROACH

It was determined at the outset of the project that household surveys would be conducted to collect the data necessary for analysis. The project team started with a fresh look at market research techniques, and the first questions to be answered were "Which type of survey should be conducted?" and "How would the survey data be used to estimate transit use?"

A self-administered household survey distributed to every household in the target area was selected as the most comprehensive and cost-effective survey technique. Questions were

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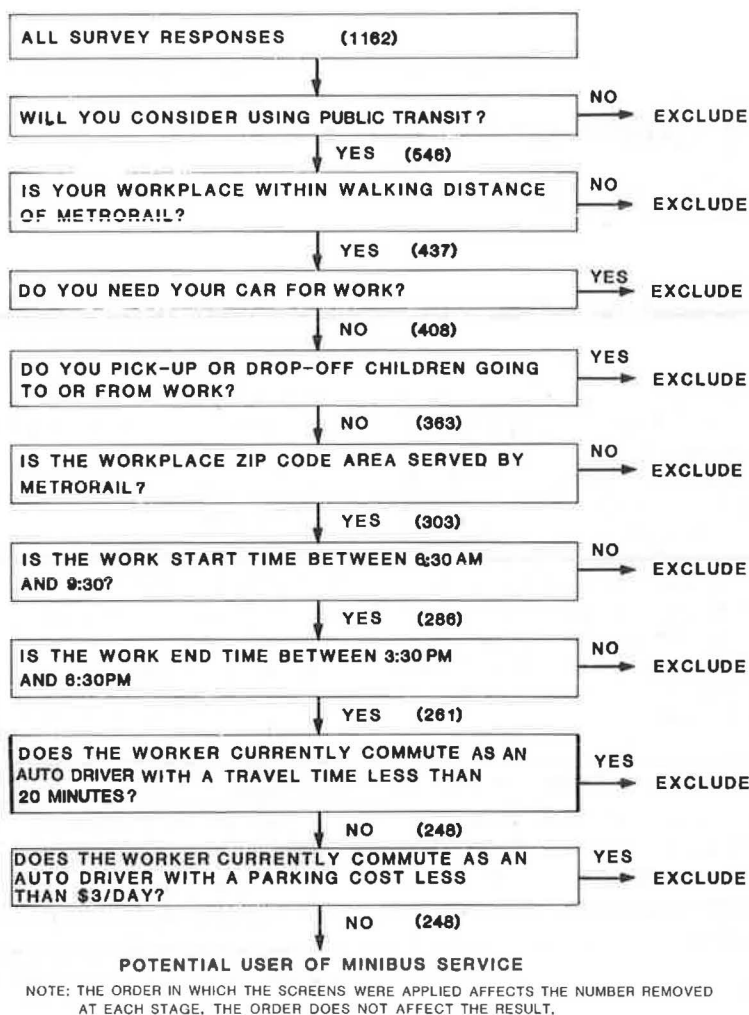


FIGURE 1 Technique for screening survey responses—Falls Church, Virginia.

posed that would enable the analyst to objectively evaluate the strength of an individual response to the basic question "Will you use the proposed feeder service?" The questions and techniques for interpreting the responses are described later. For the analyses described in this paper, the data were gathered from households in the areas of interest by leaving a form with each household, to be picked up after completion, as discussed by Hitlin et al. in another paper in this Record. A telephone survey or other household level survey technique could also have been used to obtain the data necessary for analysis.

Return rates of 23 to 24 percent were obtained in the household surveys. A small-scale telephone survey of nonrespondents was used to confirm that returns from the household survey were representative of the entire population.

Market research studies often explore What if questions, such as "Would you buy this product if it were 10 percent cheaper than product X?" In transit market research, a similar question might be of the form "Would you ride the bus if the stop were 1 block from your home?" Experience has shown that the proportion of respondents that answer yes to such questions is substantially greater than the proportion that will actually exhibit the behavior. A rule of thumb is that for activities requiring a change from current behavior, about one-

third of those indicating a change in behavior will actually make such a change. Thus transit service planning based on a stated intent to use a proposed service can lead to provision of far more service than required, excessive expenditure, and poor cost recovery.

To overcome this problem, mode choice models apply known time and cost relationships to estimate the proportion of a population that will choose to use transit. Such models tend to be unreliable for small areas, however, and disregarding stated choice behavior ignores detailed data provided by the very population for which the transit service is proposed.

Rather than apply a rule of thumb to the target group indicating a willingness to use a proposed new transit service, the approach used was to qualify the probable validity of the response by asking a series of questions that would reveal behavior patterns such that the respondent could be classified as either a probable transit user or a probable nonuser. The responses to the qualifying questions were then judged according to predetermined decision criteria. Survey responses that survived the criteria (screens) produced a subset of probable transit users at the end of the process.

The screening questions and elimination process are shown in Figure 1. The first question was, "Will you consider using

public transit to travel to and from work?" Respondents who said they would not consider transit use were excluded from the pool of potential riders.

Subsequent questions were used in a series of tests to determine whether the feeder bus or rail service would actually serve the needs of the user. These include "Workplace within walking distance of rail station?" "Workplace in zip code served by rail?" and "Work start and end times that were compatible with planned feeder bus service period?"

For the walking distance question, a specific definition of walking distance (e.g., 2 blocks, 5 min) was not established. Rather, this definition was left to be a subjective measure for each respondent, recognizing that some persons would perceive 2 blocks as too far, whereas others would be willing to walk 1/2 mi or more. The key to an individual's choice is that individual's perception of the walking distance.

The question about zip code of the place of work was used to eliminate unreasonable trips proffered by persons who obviously overstated walking distance or misunderstood the question.

The work start and end time responses could be applied as a screen because the feeder bus service being considered would operate only in the morning and evening peak hours. The service would not be a realistic work trip mode unless the individual's work schedule conformed to the times of proposed service.

A third set of questions related to activities that would make it difficult for an individual to use the combined feeder bus-rail service on a regular basis. These questions were, "Do you need your car for work?" and "Do you pick up or drop off children going to or from work?" The last question reflects the growing importance of child care for many workers. Those who responded yes to either of these questions were considered unlikely to use the proposed feeder bus service and were eliminated as potential patrons.

Finally, three questions were asked about the current trip pattern: current mode used, door-to-door travel time, and daily parking cost. Those who were currently automobile drivers and had either a door-to-door travel time of less than 20 min from

Falls Church (45 min from Centreville) or a parking cost of \$3.00/day or less were then screened out. Trip times on the bus-rail service would exceed 20 min (or 45 min, respectively) in all cases, and the cost of a bus-rail trip would be \$3.00/day or more.

The application of the screening technique yielded a pool of potential users of the feeder bus service. This estimate was then adjusted to account for frequency of use to determine daily patronage. The findings and interpretation of the survey results for each community are discussed next.

City of Falls Church

The city of Falls Church is bounded on the east and west by newly opened Metrorail stations. The city was particularly interested in determining the demand for feeder bus service at various service frequency and fare levels in order to decide whether the city should undertake provision of service and, if so, what type of service. A total of 1,162 Falls Church residents who were employed outside of the home responded to the survey, and 21 percent of them remained after application of all screens. Figure 1 shows the process and the number of respondents remaining after application of each screen. Because many responses fail on more than one screen, the number remaining at each stage depends on the order of application. Table 1 presents the number of respondents failing each specific screen.

It is noteworthy that at least 45 percent of the surveyed group passed each individual screen, so that no single question would have served as a reliable indicator of probable transit use. In combination, the responses provide a far better indication of probable behavior.

Falls Church is an established suburban residential community located only 8 mi from the Washington, D.C., central business district. Therefore, a large proportion of the work force is expected to be oriented to the downtown area. The survey revealed, however, that only 50 percent of the Falls Church workers travel to locations served by the Metrorail system. The remaining 50 percent are not even potential candi-

TABLE 1 PERCENTAGE OF RESPONSES FAILING INDIVIDUAL SCREENING QUESTIONS—FALLS CHURCH, VIRGINIA

	Yes	No
1. Will you consider using Metrorail?	(50.7)	49.3
2. Is workplace in walking distance of Metrorail station?	(47.8)	52.2
3. Do you need car for work?	21.2	(78.8)
4. Do you pick-up/drop-off children?	13.3	(86.7)
5. Is workplace zip code served by Metrorail?	(50.4)	49.6
6. Is work start time 6:30-9:30 AM?	(87.0)	13.0
7. Is work end time 3:30-6:30 PM?	(86.1)	13.9
8. Auto driver, travel time < 20 minutes?	50.0	(50.0)
9. Auto driver, parking cost < \$3.00/day?	55.7	(44.3)

() = group considered potential transit riders.

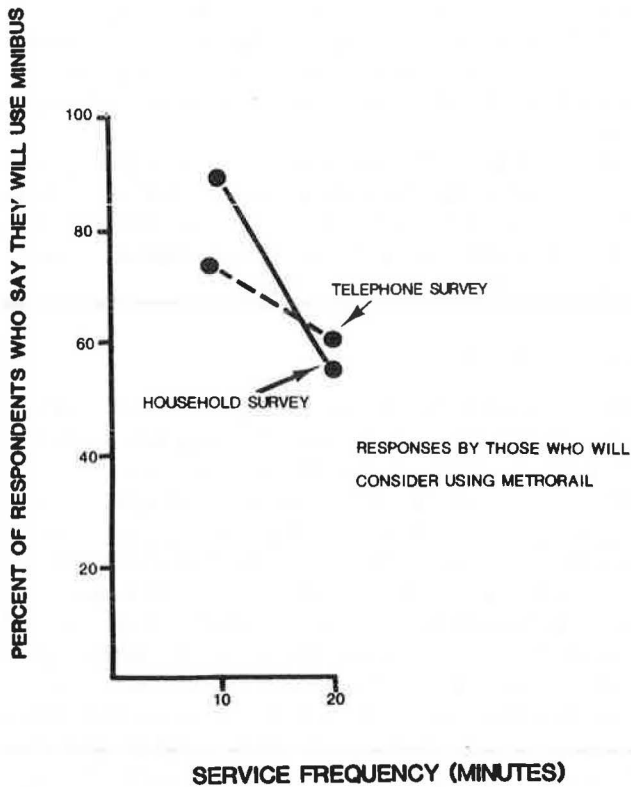


FIGURE 2 Falls Church, Virginia, transportation survey elasticity to frequency as reported by respondents.

dates for a feeder bus service. Thus, whereas only 21 percent of the resident workers were identified as possible system users, they represented over 40 percent of the total potential market.

The potential transit market established through the screening process was based on a service description that featured a free service operated at a 10-min frequency. To develop ridership estimates, it was necessary to adjust for probable frequency of use and for alternative fare and service levels. To provide information on these questions, the Falls Church survey asked, "How many days per week would you use this service?" "Would you ride if the fare was: free, 25 cents, 50 cents, 75 cents?" and "Would you ride if the frequency was: 10 min, 15 min, 20 min?"

On the basis of responses to these questions, for that portion of the sample that answered yes to the question "Would you consider using Metrorail?" the following factors were developed (Figures 2 and 3):

Conversion from potential riders to typical day = 0.60.

This factor was based on response to the question "How many days per week would you use this service?"

Percentage of potential riders who would use the service at a given fare—

Fare (cents)	Percentage (%)
0	100
25	99
50	64
75	31

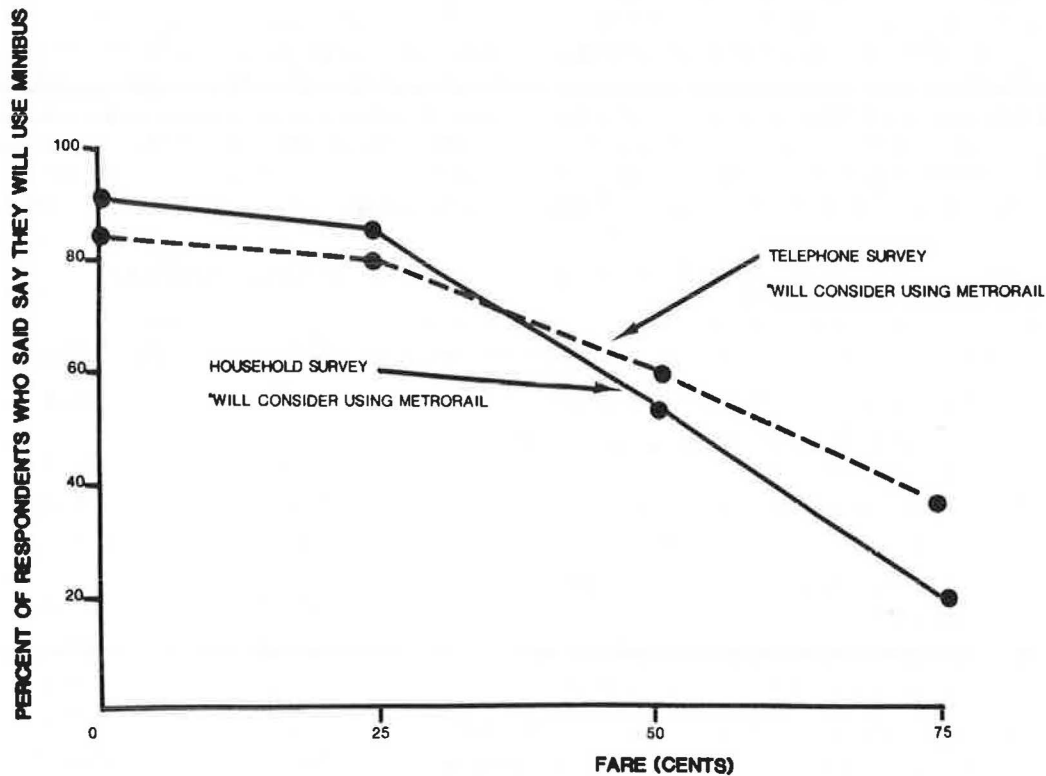


FIGURE 3 Falls Church, Virginia, transportation survey elasticity to fare as reported by respondents.

TABLE 2 FALLS CHURCH, VIRGINIA, PATRONAGE ESTIMATES

SERVICE FREQUENCY	FARE LEVEL		
	Free	\$.25	\$.50
10 minutes	1324 (± 202)	1308 (± 200)	844 (± 164)
15 minutes	1116 (± 186)	1106 (± 186)	718 (± 152)
20 minutes	900 (± 160)	812 (± 162)	580 (± 138)

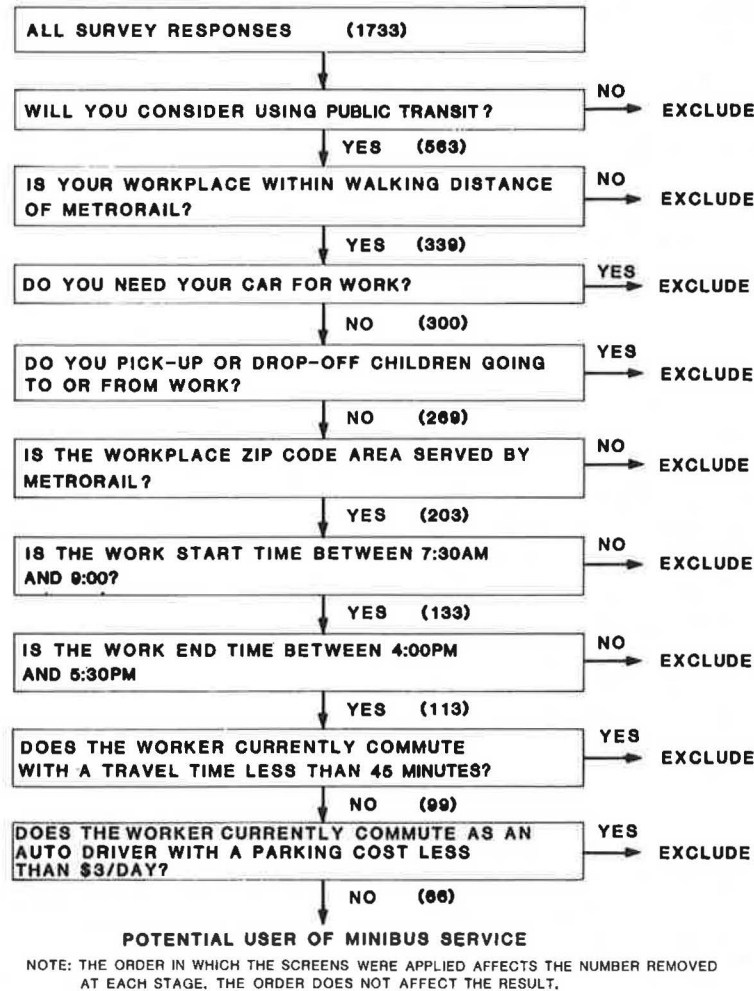


FIGURE 4 Technique for screening survey responses—Centreville, Virginia.

Percentage of potential riders who would use the service at a given frequency—

Frequency (min)	Percentage (%)
10	100
15	84
20	68

Estimates of typical daily ridership for each fare and frequency combination were then prepared. These estimates are presented in Table 2.

These data permit the city to evaluate the economics and service benefits of various operating plans and, if it chooses to implement a service, to offer the service best suited to its goals. Further, because the survey was administered uniformly throughout the city and the residence block of respondents was included in the survey data, developing a routing plan targeted to the greatest concentration of potential riders is possible.

Centreville, Fairfax County

Centreville is a rapidly growing residential community located 20 mi from the downtown employment area. Fairfax County,

TABLE 3 PERCENTAGE OF RESPONSES FAILING INDIVIDUAL SCREENING QUESTIONS—
CENTREVILLE, VIRGINIA

	Yes	No
1. Will you consider using Metrorail?	(29.9)	62.8
2. Is workplace in walking distance of Metrorail station?	(25.2)	73.1
3. Do you need car for work?	32.1	(67.9)
4. Do you pick-up/drop-off children?	13.2	(86.8)
5. Is workplace zip code served by Metrorail?	(27.0)	73.0
6. Is work start time 6:30-9:30 AM?	(81.7)	18.3
7. Is work end time 3:30-6:30 PM?	(61.2)	48.8
8. Auto driver, parking cost < \$3.00/day?	56.6	(43.4)

() = group considered potential transit riders.

through Washington Metropolitan Area Transit Authority, started a new feeder bus service to the Metrorail terminal station, approximately 9 mi to the east, in June 1986. Before service initiation, a market research analysis was conducted in Centreville to forecast the number of patrons for the new feeder service. Fairfax County representatives, who had already determined to operate a basic service, also wanted to know whether an earlier or later bus trip would be appropriate.

The market analysis in Centreville was very similar to the process used in Falls Church, as shown in Figure 4 and Table 3. Some of the criteria, such as travel time to work by automobile, were adjusted to reflect the geographic differences between the two communities. Out of 1,733 workers responding to the survey, 563 expressed an interest in using public transit. However, only 66 workers survived all of the screens. These surviving samples represented workers likely to be regular users of the service. To obtain a typical day estimate, a factor of 0.65 was applied to account for the probable frequency of use stated by respondents. On June 26, 1986, 1 week after initiation of service, the new bus route carried 41 patrons during the a.m. period. Counts on 3 days in October 1986 showed 35, 36, and 51 a.m.-period passengers. The observed ridership suggests that the forecasting technique produces reasonable patronage estimates in the short run. A follow-up survey was planned for Spring 1987 to confirm the screening factors used to model patron decisions and to put bounds on the time frame that the demand estimate covers.

SUMMARY

The direct survey technique followed by a screening on the basis of the characteristics of individual workers has proven to

be an efficient technique for developing reasonable estimates of the market for a new transit service. Real-world factors that affect an individual's choice of mode are reflected in the screens, and each response can be examined in detail. An added benefit is that the procedure can easily be explained to individuals who have little technical knowledge, so that elected officials and citizens groups can evaluate the reasonableness of patronage forecasts.

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