enough). To avoid angering waiting passengers, many systems make it a practice to deadhead vehicles on streets that have no bus service.

Another deadheading option is to have only a fraction of the runs on a route return in service while the remainder deadhead. This strategy, called "alternating deadheading," is studied in Furth (6). The simplest alternating deadheading schedule is to have every other bus deadhead. In an application on an available freeway, alternating deadheading saved 4 of 29 buses on a busy route.

COMPARISON OF LOCAL SERVICE STRATEGIES

Table 1 gives a summary of the four major strategies for local service. Included are operational and public information problems, level of service impacts, and the conditions that most favor efficient operation of each strategy.

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Maintenance and Operating Costs of Small Buses

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ABSTRACT

Maintenance and operating cost data are provided for small buses. These data were obtained by analyzing the maintenance and fuel use records of 187 small buses from 16 transit properties located in different parts of the country. Specific cost data are provided for four types of small bus: vans and modified vans, body on van chassis, body on truck chassis, and purpose built. Both the labor hours and the materials cost are calculated on a per mile basis. The effects of climate and duty cycle on maintenance cost are evaluated. The procedure used in collecting the data and the characteristics of the data bases developed to store and analyze the data are described.

One of the important decisions facing small urban area and rural transit decision makers, who are interested in establishing new transit systems, is whether to invest scarce public funds in lower-capital-cost, more-efficient, less-durable transit vehicles or higher-capital-cost, less-energy-efficient, more-durable ones. Although previous research has provided reliable life-cycle cost and fuel use estimates for taxi vehicles and full-size standard transit vehicles, little information is available for vanpool vehicles, medium-size transit vehicles, or nonstandard, full-size transit vehicles (such as body-on-chassis-type school buses converted for transit use). If vehicle purchase decisions are to be soundly based, life-cycle cost comparisons and energy use information for those types of vehicles are essential.

Toward this end Arthur D. Little, Inc., undertook a project entitled "Small Transit Buses: A Manual for Improved Purchasing, Use and Maintenance" under the sponsorship of UMTA. This project was conducted through the National Cooperative Transit Research and Development Program. The general objective of this research was to develop a workbook-style manual that can be used by local transit operators and to identify key recommendations that might feasibly be applied by transit operators, local governments, states, and UMTA to substantially improve procurement, appropriate use, and maintenance for small transit buses. Furthermore, the manual was to assist individuals in the cost-effective procurement, maintenance, and operation of buses in a wide range of local, institutional, service, and operating environments. The manual will be available shortly.

The most important portion of this research project, the part dealing with what the costs of maintaining an operating small buses are and how these costs were obtained, is described. This work required collecting data through visits to a number of transit properties, developing data bases, and analyzing the data to obtain the required information.

DATA COLLECTION APPROACH

A review of the literature indicated that the prevalent method of estimating life-cycle maintenance costs is as follows:

- List the principal vehicle components (e.g., engine, transmission);
- Estimate the number of miles between repair or replacement of each component;
- Estimate the cost to repair or replace each component;
- For each component, divide the expected life mileage of the bus by the number of miles between repair or replacement and multiply by the cost of the component; and
- Add costs associated with each component.

This approach is particularly useful for comparing components made by different manufacturers and for scheduling preventive maintenance or inspections. However, it does not guarantee that the total cost to maintain the bus will be measured, because a large part of bus maintenance costs involves small repairs, adjustments, and inspections. Also, a study of component life requires a data collection period at least as long as each component's life.

The approach used for this project has been to attempt to measure total maintenance costs accurately and to make the results applicable to a wide range of bus types and operating conditions. This was done in three steps:

- Develop a test plan that includes appropriate combinations of bus types and operating conditions;
- Request the participation of transit properties that fulfill the requirements of the test plan; and
- Visit the properties and record, in detail, all work performed on specific buses during a period of approximately 6 months.

These steps resulted in data bases containing a complete maintenance history "snapshot" covering 6 months for each bus studied. The 6-month period amounted to about 10,000 miles per bus. This is certainly less than the mileage required to determine the life of most bus components. However, it was assumed that by studying several buses in similar operating conditions and at different odometer mileages the average maintenance costs under given conditions could be estimated. In retrospect, this assumption has held up reasonably well and the statistical confidence of the results can be improved by simply adding more 6-month "snapshots" to the data base.

The data collection plan began with a broad definition of the many areas of cost (cost elements) associated with operation and maintenance, such as brake repair and engine tuneups. A list of the cost elements, which an attempt was made to quantify, follows:

- Body work,
- Wheels,
- Brakes,
- Axles,
- Suspension system,
- Steering,
- Interior,
- Air conditioning,
- Special equipment (wheelchair lifts),
- Fare collection,
- Voice communication,
- Fuel,
- Chassis,
- Bumpers,
- Windows and wipers,
- Doors,
- Engine,
- Fuel system,
- Electrical system,
- Exhaust,
- Engine cooling system,
- Driveline,
- Tires, and
- Oil.

Each cost element was then examined to determine the principal factors (independent variables) that can affect it. Some of the variables examined are bus type, duty cycle, odometer mileage, and climate.

Then, on the advice of consultants familiar with the U.S. transit industry, 27 properties were selected that, together, fulfilled the requirements of the data collection plan. Letters describing the project and requesting their participation were then mailed to the properties. Subsequently a telephone call was made to each property to confirm their willingness to support this research and to establish a schedule for on-site visits.

In preparation for visits to the properties, two data collection forms were developed, one for characterizing details of each bus and its operating environment and one for recording the maintenance performed on each bus. The bus characteristics data collection form was seven pages long and included space for entering engineering data as well as subjective comments from interviews with personnel at the transit properties. The maintenance reporting form included space for the following items:

- Bus identification number;
- Time period covered;
- Odometer mileage range covered;
- Fuel consumed during period; and
- Information on all maintenance activities, including (a) odometer reading, (b) job description, (c) labor hours spent, (d) parts costs, and (e) total job cost.

With the data forms in hand, investigators spent 1 day at each of the 27 selected properties. The properties surveyed are given in Table 1.

Two principal sources of information used during the site visits were staff interviews and historical work orders. Maintenance staff members were interviewed for details of vehicle characteristics, duty cycle descriptors, and maintenance experience. Records of daily work orders were reviewed and, usually, photocopied as the source for maintenance labor hours and parts costs. As might be expected, there was a wide variation in the forms of the available

TABLE 1 Properties Surveyed for Small Bus Maintenance and Cost Data

Property	Location
Included in Analysis	
Care-A-Van	Fort Collins, Colo.
Transfort	Fort Collins, Colo.
SEMTA, Macomb	Detroit, Mich.
MTA	Flint, Mich.
CY-Ride	Ames, Iowa
The Bus	Greeley, Colo.
STS	Saginaw, Mich.
GET	Bakersfield, Calif.
JTS	Jackson, Mich.
RTA	Cleveland, Ohio
CCCTA	Contra Costa, Calif.
TRT	Norfolk, Va.
SEMTA, Port Huron	Detroit, Mich.
Pierce Transit	Tacoma, Wash.
Intercity Transit	Olympia, Wash.
OCTD	Orange County, Calif.
Not Included in Analysis	
Public Service	New Orleans, La.
SEMTA, Taylor	Detroit, Mich.
Bay Metro	Bay City, Mich.
SCAT	El Paso, Tex.
TARC	Louisville, Ky.
Metro Transit	Kalamazoo, Mich.
SEMTA, Pontiac	Detroit, Mich.
RTA	Sumter, S.C.
SST	Steamboat Springs, Colo.
The Ride	Ann Arbor, Mich.
Road Runner	Lowell, Mass.

data, from extensive computer files to handwritten notes in a spiral binder. All forms were useful and as much data as possible was gleaned from each source. However, not all types of data were readily available at each location. Maintenance record-keeping policies fell into the following four broad categories:

- Computer files containing coded descriptions of work done plus parts costs and labor hours;
- Individual handwritten work orders describing work done, labor time, and parts replaced (and parts costs);
- Summaries of parts costs and labor time, with little detail of work done; and
- Incomplete records of work done, perhaps with no indication of odometer mileage.

The most common practice, by far, was the use of individual work orders. These were usually found, ordered chronologically, near the shop area. Because the time period of study was only the previous 6 months, all pertinent work orders were readily available. The work orders collected are the basis of billing and, often, maintenance scheduling at the garages and seemed to be well kept. This gives confidence in the completeness and accuracy of the data.

To prepare for the analysis, record-keeping procedures were established and two computer data bases were developed. The primary purpose of record keeping was to assure that all primary data were collected completely, reviewed for quality control, and available for analysis.

DATA REDUCTION

From the volume of information collected at each property, several key parameters were selected for tabulation and entry into two computer data bases, the Vehicle Characteristics Data Base (BUS) and the Maintenance Events Data Base (MAINT). BUS contains specifics of the vehicle design, the environment in which the vehicle operates, and the service it performs. MAINT is linked to BUS by a unique bus ID number and contains the details of the maintenance and operations events related to that specific bus. The information in MAINT is set up with codes to describe each event, such as replace some gallons of diesel fuel or repair the shocks on the front end, and with the concurrent cost information, such as number of gallons (with cost per gallon to be added later) or labor hours plus materials costs.

The data file BUS contains the following elements of information:

- Bus ID number,
- Authority ID number,
- Climate,
- Bus type,
- Bus make and model,
- Year built,
- Gross vehicle weight rating (GVWR),
- Seating capacity,
- Wheelchair provisions,
- Fuel type,
- Brake type,
- Average speed en route,
- Stops per mile,
- Average peak passenger load,
- Duty cycle,
- Acquisition cost,
- Resale value,
- Maintenance records--beginning mileage,
- Maintenance records--ending mileage, and
- Comments.

The data file MAINT contains the following elements of information:

- Bus ID number;
- Origin of maintenance (e.g., scheduled or driver report);
- Maintenance action (repair, replace, or inspect);
- Major system ID (e.g., electrical or front end);
- Part ID (e.g., disc pads or muffler);
- Labor hours;
- Split, actual, not applicable, or estimated (SANE) cost index for labor;
- Materials cost;
- SANE index for materials cost;
- Contracted cost;
- SANE index for contracted cost;
- Total cost, nonstandard;
- SANE index for total cost;
- Unit quantity; and
- Unit cost.

More than 200 separate codes were used to encode the maintenance data. For this analysis, the codes were combined into seven bus systems:

- Brake and suspension,
- Engine and driveline,
- Electrical,
- Body and interior,
- Wheelchair,
- Auxiliary equipment, and
- Unspecified.

Each work event was coded as repair, replacement, or inspection, when the distinction could be made. Records of fuel use were also contained in the MAINT data base.

The SANE index for labor, referred to previously, made it possible to account for the variability in the source of maintenance labor hours and costs. Split record ("S") is used when the total labor hours are obviously divided over two or more events. For instance, if it is given that 3 hours were spent changing spark plugs and fixing a flat tire, the 3 hours would be split between two records in MAINT and the code "S" applied to the labor hours. Again, this allows for rapid coding and an opportunity for later quality control. Actual ("A") is used when the information is accurate and complete, as in "1 hour spent replacing a speedometer cable." Not applicable ("N") is used in circumstances where labor is not charged, as during daily refueling. Estimated ("E") is used when no specific details are available and engineering judgment is required. For instance, if a maintenance event was found that involved the replacement of a speedometer cable with no associated labor charge, an "E" was entered next to a blank labor hour field, which was later filled with an estimate of the time required.

These data bases were appropriate for rapid coding of the basic elements of the data collected. They provided the basis for quality control and were sufficient for the primary regression analyses.

Data were accumulated from 27 transit properties representing 316 buses. However, not all properties could provide complete details of maintenance labor and parts costs. This necessitated dropping some buses from further analysis. Analysis was actually performed on 187 buses from 16 authorities (Table 1) encompassing about 2.37 million bus-miles and 1,200 bus-months of operation, including more than 5,000 separate maintenance events.

In preparation for statistical data analysis, the definitions of the independent parameters were reviewed and put in final form. The key independent parameters are described in the following sections.

Bus Type

The fleet of small transit buses was divided into four categories:

1. Van--A standard, light-duty automotive vehicle with no extensive body modifications beyond an after-market raised roof or the addition of a wheelchair lift.
2. Body on van chassis--A light-duty van chassis with a full passenger body; for example, a Collins Omnibus body on a Dodge B-300 chassis.
3. Body on truck chassis--A complete bus body built onto a truck chassis supplied by a major vehicle and engine manufacturer; for example, a Superior Transliner body on a GMC chassis.
4. Purpose built--A bus built onto a chassis or frame specifically designed for that purpose and built by the bus builder; for example, a TMC Citycruiser.

Climate

Three climatological parameters were used to quantify a "climate rating" for the general location of each authority:

- Annual inches of snow,
- Annual degree-days, and
- Annual days of precipitation.

Each parameter represents an average of many years of data at each location. The data were obtained from National Oceanic and Atmospheric Administration reports. One consideration is that this rating is not tailored to the specific time range of the maintenance data collected, although it does represent the general year-round climate the buses have been exposed to. Also, data for all individual cities are not available so data from the nearest major city were selected.

Table 2 gives a summary of the elements that make up the climate rating code for each location. The codes appear to accurately represent the climatological differences between the various locations and should be sufficient for investigating the broad effects of climate on maintenance costs. Three ratings codes were used. Examples of each are given in Table 2.

TABLE 2 Summary of Climate Rating Code

Climate	Characteristics
Mild (Code 1)	On average, less than 20 in. of snow and less than 4,000 degree-days[a] per year (e.g., Bakersfield, Calif. and Norfolk, Va.).
Moderate (Code 2)	On average, more than 4,000 degree-days and less than 100 days of precipitation per year (e.g., Tacoma, Wash. and Fort Collins, Colo.).
Severe (Code 3)	On average, more than 20 in. of snow, more than 4,000 degree-days, and more than 100 days of precipitation per year (e.g., Flint, Mich. and Ames, Iowa).

Note: Climate data can be obtained from the National Oceanic and Atmospheric Administration reports.

[a]"Degree days" is determined as the sum of (65°F-average temperature during the day) for each day that the average temperature is less than 65°F.

Duty Cycle

Several measures were available from which to synthesize a duty cycle code. These included

- Average speed while moving;
- Typical number of passenger stops per mile;
- Average peak passenger load, to be compared with seating capacity;
- Maximum route speed; and
- Service descriptors (e.g., demand-response, elderly and handicapped, school tripper, shuttle, fixed route).

These measures were examined and found to be highly correlated; that is, as one measure changed, most of the others also changed in a predictable fashion. The most fundamental descriptor of duty cycle is the typical number of passenger stops per mile. This appears to readily separate the basic service areas. High numbers of stops per mile occur in city or urban areas, medium numbers of stops per mile indicate a low-density city or perhaps a suburban area, and low numbers of stops per mile indicate longer distance runs, as in rural areas. Higher vehicle speeds tend to accompany lower stops per mile. The wear that a bus must withstand is directly related to the amount of stop-and-go action it encounters--especially as evidenced by brake and front-end work. As an example of its application, this duty cycle descriptor allows a distinction between the maintenance costs for a high-mileage bus that has "worked in the city" to one that has had "an easier life." Table 3 gives definitions of various duty cycles.

TABLE 3 Summary of Duty Cycle Rating Code Characteristics

Duty Cycle	Characteristics
Mild (Code 1)	On average, less than or equal to 1 stop per mile (e.g., a rural elderly and handicapped route).
Moderate (Code 2)	On average, more than 1 but fewer than 3 stops per mile (e.g., a demand-response city route).
Severe (Code 3)	On average, more than or equal to 3 stops per mile (e.g., a fixed city route).

TABLE 4 Total Maintenance Mileage and Number of Buses in the Data Bases

	Bus Type							
	Vans		Body on Van Chassis		Body on Truck Chassis		Purpose Built	
Duty Cycle	Maintenance Miles	No. of Buses	Maintenance Miles	No. of Buses	Maintenance Miles	No. of Buses	Maintenance Miles	No. of Buses
Light	11,700	4	395,700	36	57,000	6	0	0
Medium	73,000	6	316,800	21	193,400	19	0	0
Heavy	83,500	8	20,700	3	12,300	1	1,203,000	83

Average Mileage

This is the midpoint of the mileage range of each bus covered in the survey or, in general terms, the mileage of each bus at the time of the survey. This became a principal descriptor of maintenance costs, following the hypothesis that buses cost more to maintain as they age.

As described next, various statistical techniques were applied to generate meaningful maintenance and operating cost data on small buses.

SUMMARY OF RESULTS

The data bases contain the maintenance events and costs for about 2.37 million miles of bus operation. The data given in Table 4 indicate how these maintenance miles are distributed over the four bus types and three duty cycles. The number of buses in each combination is also shown. Although an attempt was made to survey buses with a wide range of operating conditions, the distribution on Table 4 seems to indicate the way bus types and duty cycles are usually combined. All of the purpose-built buses are used in heavy stop-and-go service. The body-on-van-chassis buses are used principally in light and medium service and the heavier body-on-truck-chassis buses are used principally in medium-duty service. Vans, perhaps because of their flexibility, appear in all duty cycles.

These data bases can be used to obtain many different types of useful information. For the purpose of developing a manual on small buses, they were analyzed in several different ways as described hereafter.

Figure 1 shows the 95 percent confidence ranges of the total maintenance costs of the four types of small buses, which were obtained assuming a labor rate of $10 per hour. As can be seen, the maintenance cost for a body-on-truck-chassis bus may lie between 16 and 28 cents per mile, whereas that for vans may lie between 3.4 and 6.2 cents per mile. A substantial portion of the variability is explained by variations in climate, duty cycle, and cumulative mileage, which are given in Tables 5 and 6.

Table 5 gives estimated maintenance requirements for each type of small bus. In this table, the requirements are expressed in terms of labor hours and materials cost. From this table, it is easy to obtain maintenance cost per mile estimates given the bus type, climate severity, duty cycle characteristics, and local labor rate in dollars per hour. It can be seen from the table that maintenance requirements are generally strongly dependent on climate, duty cycle, and bus type. In developing the costs in Table 5 from the regression equations, the trends in cost have been smoothed out in those cases in which the equations provided results counter to engineering judgment and past knowledge of maintenance costs.

The labor hours and materials cost for body-on-van-chassis buses is shown independent of climate severity. This is not because climate severity is not considered an important variable for this bus type but because sufficient data were not available to determine a statistically valid relationship. Similar comments apply to the materials cost for purpose-built buses.

Using the data bases, the effects of bus odometer mileage on the maintenance requirements can also be determined (Table 6). To incorporate mileage effects, simply multiply the labor hours and materials

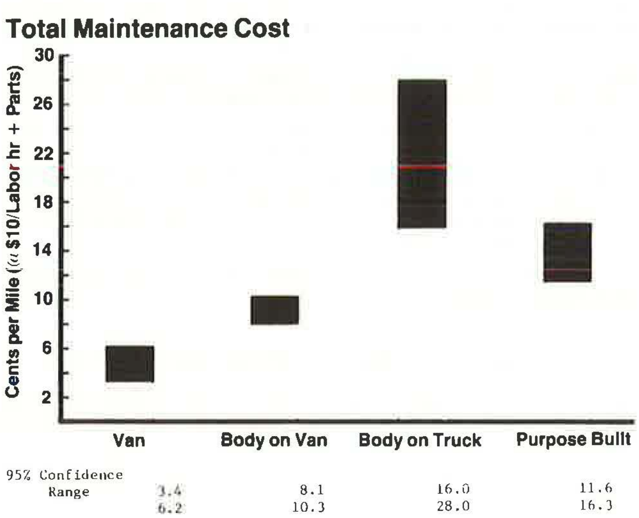

FIGURE 1 Data scatter in total cost per mile for different bus types.

TABLE 5 Small Bus Maintenance Requirements

Climate	Duty Cycle	Van or Modified Van	Body on Van Chassis	Body on Truck Chassis	Purpose Built
Labor Hours per 100 Miles					
Mild	Mild	0.17	0.46	0.61	0.29
	Moderate	0.22	0.57	0.77	0.38
	Severe	0.27	0.71	0.96	0.50
Moderate	Mild	0.22	0.46	0.79	0.31
	Moderate	0.28	0.57	0.99	0.41
	Severe	0.35	0.71	1.23	0.54
Severe	Mild	0.30	0.46	1.08	0.33
	Moderate	0.38	0.57	1.36	0.44
	Severe	0.48	0.71	1.69	0.58
Materials Cost per Mile (1983 cents)					
Mild	Mild	1.2	4.3	5.9	2.6
	Moderate	1.3	4.7	6.5	3.9
	Severe	1.4	5.2	7.1	6.0
Moderate	Mild	1.2	4.3	6.1	2.6
	Moderate	1.4	4.7	6.8	3.9
	Severe	1.5	5.2	7.5	6.0
Severe	Mild	1.6	4.3	8.1	2.6
	Moderate	1.8	4.7	8.9	3.9
	Severe	2.0	5.2	9.8	6.0

TABLE 6 Mileage Factors

	Mileage Factor for Labor Hour				Mileage Factor for Materials Cost			
Mileage at Start of the Year	Van or Modified Van	Body on Van Chassis	Body on Truck Chassis	Purpose Built	Van or Modified Van	Body on Van Chassis	Body on Truck Chassis	Purpose Built
0-10,000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10,000-20,000	1.00	1.05	1.05	1.01	1	1.1	1.01	1.01
20,000-30,000	1.00	1.11	1.10	1.02	1	1.2	1.03	1.02
30,000-40,000	1.00	1.16	1.14	1.03	1	1.3	1.04	1.03
40,000-50,000	1.00	1.22	1.19	1.04	1	1.4	1.05	1.04
50,000-60,000	1.00	1.27	1.24	1.05	1	1.5	1.06	1.05
60,000-70,000	1.00	1.33	1.29	1.06	1	1.6	1.08	1.06
70,000-80,000	1.00	1.38	1.34	1.07	1	1.7	1.09	1.07
80,000-90,000	N/A[a]	1.44	1.38	1.08	1	1.8	1.1	1.08
90,000-100,000[b]	N/A[a]	1.49	1.43	1.09	1	1.9	1.12	1.09

[a]All vans in the survey had fewer than 80,000 odometer miles.
[b]Above 100,000 miles, use the following formulas: Mileage factor for labor hours = 1 + (n/100) x (mileage/10,000) and mileage factor for materials cost = 1 + (m/100) x (mileage/10,000) where n is 0, 5.5, 4.8, and 1 for van or modified van, body on van chassis, body on truck chassis, and purpose built, respectively, and m is 0, 10, 1.3, and 1 for van or modified van, body on van chassis, body on truck chassis, and purpose built, respectively.

cost obtained from Table 5 by appropriate mileage factors given in Table 6.

The data collected included the quantity of fuel consumed by each bus during the period studied. This allows an estimation of miles per gallon (MPG) for each bus type. The average values are given in Table 7.

TABLE 7 Average MPG of Different Types of Small Buses

Bus Type	Fuel Type	Average MPG	Standard Deviation, MPG
Van	Gasoline	8.9	6.3
Body on van	Gasoline	6.5	1.7
Body on truck	Gasoline	5.1	1.8
Purpose built	Diesel	6.1	2.8
Purpose built	Gasoline	3.6	0.0

In addition to these general results, the data base can be used to obtain more detailed information on maintenance cost. An example is given in Table 8. In this table, the maintenance cost is given in terms of cents per mile, assuming a labor rate of $10 per hour. As can be seen, a body-on-truck small bus is more expensive to maintain than the other types, and vans are the least expensive. Also, maintenance of brakes and suspension and engine and driveline dominate the overall maintenance requirements.

The maintenance cost results presented in these tables are statistical averages of data that, in fact, have a significant amount of scatter. The reasons for the scatter are

- The maintenance survey period, about 4 to 8 months, is not always long enough to capture many of the major maintenance events for every bus.
- One bus may have entered a period of intensive renovation and consequently had a low mileage during that period of time. Another bus, in similar conditions, may have accumulated higher mileage, because little major maintenance work was performed.
- The make and model of the bus can significantly affect maintenance costs. Proper specification and quality of design, manufacture, and assembly are obviously important but could not be adequately addressed in this study.

TABLE 8 Total Maintenance Cost per Mile by Bus Type and System (cents per mile)

System	Van	Body on Van	Body on Truck	Purpose Built
Unspecified	1.12	1.03	2.44	2.58
Brakes and suspension	1.24	3.53	6.15	4.00
Engine and driveline	1.03	2.34	7.59	2.65
Electrical	0.44	1.07	2.19	1.51
Body and interior	0.42	0.54	0.82	1.74
Wheelchair	0.32	0.39	1.15	0.55
Auxiliary equipment	0.15	0.34	1.76	0.91
Total	4.72	9.24	22.10	13.94

Note: Cost per mile is calculated as: sum of parts cost + labor @ $10 hr)/Sum of maintenance miles.

The data in Figure 1 suggest that the following approximate 95 percent confidence bands be applied to the mean values of total maintenance cost per mile derived from Tables 5 and 6: ±35 percent for vans, ±10 percent for body-on-van-chassis, ±30 percent for body-on-truck-chassis, and ±20 percent for purpose built.

It is believed that the data presented will prove valuable in making decisions about the purchase, maintenance, and operation of small buses. However, it is recommended that any quantitative analysis performed using these data be tempered with the user's own experience or that of others in the transit industry.

CONCLUSIONS AND RECOMMENDATIONS

Maintenance and operating cost data for small buses have been provided. In addition, the process of gathering the data and the characteristics of the data bases developed to analyze these data have been discussed. Specific data provided in this paper are

- Small bus maintenance cost per mile in terms of labor hours and materials costs for different bus types, climate severity, and duty cycle characteristics;
- Small bus fuel use;
- Effects of odometer mileage on maintenance cost per mile; and
- Maintenance cost per mile for different systems for each bus type.

In addition, the potential for using the data base for developing maintenance and operating cost data that are specific to a particular application has been demonstrated.

It is recommended that this effort be continued because the usefulness of the data bases will decline over time unless they are periodically modified to

- Add information on new types of small transit buses entering the market and
- Update information on maintenance and operating costs of buses already included in the data bases.

Also, a similar project should be undertaken to investigate reliability of small buses, which is a major factor affecting the quality of service, the cost of maintenance, and the spare bus capacity required to meet service objectives. Therefore, the users of small buses will benefit from a study in which the maintenance records of a large number of small buses are examined to evaluate their reliability. The end result of such a study will be estimates of reliability of various bus types, expressed in terms of time-to-failure and time-to-repair statistics for different components.

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Revitalizing Express Bus Services in a Suburban Community: A Public-Private Partnership

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ABSTRACT

In response to rapidly deteriorating privately owned and operated express bus service, Prince William County, Virginia, developed a program designed to stabilize and improve services. The program, conceived by a citizens advisory committee and initiated with state and local funding, uses a public-private partnership whereby the local government purchases and remanufactures suburban coaches and then leases the coaches to a private operator. Lease fees are nominal, and the private operator is contractually obligated to the local government to provide all necessary coach maintenance. Thus the local government in effect provides a capital subsidy to a private operator and helps provide reliable public transportation without becoming the actual provider. The local government reviews routes and schedules and assists in marketing but does not defray operating costs. To date, the county has remanufactured and leased 10 suburban coaches to a local private operator. This has resulted in the availability of more reliable, more comfortable, and safer express bus service for county commuters. Express bus patronage is increasing, and the county hopes to remanufacture and lease an additional 10 coaches. The program appears to be successful and incorporates several strategies that may be of interest to suburban jurisdictions considering initiatives in express bus operations.

Prince William County, Virginia, is a rapidly developing suburban jurisdiction in the Washington, D.C., metropolitan area with a 1980 population of 144,700. Two Interstate highways, I-95 and I-66, provide access to key employment centers in Washington as well as to the Pentagon, Crystal City, Rosslyn, and Tysons Corner. Although most daily work trips from Prince William County are made by single-occupant vehicles, other modes have assumed greater importance in recent years. Throughout the 1970s a private operator provided express bus services from the residential eastern part of the county. However, in the late 1970s and early 1980s, deteriorating rolling stock, under capitalization, mediocre management, and severe winter weather contributed to unreliable and uncomfortable service. County residents were presented with the alternative of participating in ridesharing arrangements that were sponsored by a