

Use of Electronic Computers in Maintenance Cost Accounting

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• NOTABLE PROGRESS has been made, in the last year and a half, in the use of electronic computers in highway location and design, in bridge design, and in traffic studies. Many problems have been successfully resolved on the electronic computer with substantial savings in time, manpower, and cost. This experience has clearly demonstrated the usefulness of this high-speed computing device in highway work. The next logical step is to extend the application of the electronic computer to as wide a range of highway department operations as practicable.

Highway maintenance is an area in which electronic computers can be used to good advantage. Comprehensive, accurate records of maintenance operations and their costs are essential to good highway management. The orderly scheduling of work, the preparation of budgets, the development of cost analyses, and the control of expenditures all require a comprehensive system of records including detailed cost accounts. For maximum usefulness, this record should be in sufficient detail and so arranged that it will:

1. Provide accurate, current information on all maintenance performed on each highway system;
2. Permit the development of unit costs for each maintenance operation;
3. Permit the development of cost comparisons to evaluate the effectiveness of materials, methods, and equipment;
4. Provide information on maintenance cost trends for use in long-range planning;
5. Indicate limits of maintenance effort beyond which reconstruction should be undertaken;
6. Permit the development of sound equipment rental rates; and

7. Provide data necessary to determine equipment obsolescence.

The need for records of this kind is generally acknowledged and has been cited repeatedly in discussions of highway maintenance. However, the volume of work involved in using such records has discouraged their adoption. As a result, many maintenance cost-accounting systems in operation today are designed principally to satisfy fiscal requirements. In these cases, maintenance expenditures generally are recorded by broad categories only and are not broken down into the detail necessary for correlating costs with the many factors which influence them. It is this detailed information that provides the guides or indicators by which maintenance performance can be gauged and which aid in the evaluation of design and construction practices.

The electronic computer offers a means of reducing what would be a major undertaking to a relatively painless routine chore largely eliminating the difficulties presently involved in the optimum usage of detailed maintenance cost records.

The first prerequisite for accumulating adequate maintenance cost data is the establishment of a system of control sections (1). Control sections have proved to be an effective device for obtaining and assembling detailed data on highway costs in a systematic manner and are now used in a majority of the states. Once the highway system has been subdivided into control sections each such section is identified by code and serves as a basic unit for reporting, recording and compiling costs.

A second prerequisite is the development of accounting procedures which can accumulate all necessary statistical and cost data and such other information as

may be required. Such a procedure is available in the Accounting Manual for State Highway Departments now being completed in revised form by the Committee on Uniform Accounting of AA-SHO. The maintenance and equipment accounting procedures provide the basic activity classifications for reporting and recording maintenance costs, and, together with the control-section system, form the basic controls for accurate maintenance cost accounting. In the section on maintenance accounting, there are 79 basic activity classifications covering general maintenance, traffic services, and unusual or disaster operations; such items as surface patching, surface blading or dragging, resurfacing, shoulder reshaping, repairing and maintaining bridges, snow removal, litter cleaning, and repairing traffic signs.

Labor, materials, and equipment charges against each control section as reported on labor time sheets, material sheets, and equipment usage reports, plus a prorated overhead charge in each case, can be recorded on punched cards or tape for each of these activity classifications. Actual cost records in this form provide the basic data from which total costs, average costs or unit costs can be readily obtained on the electronic computer in whatever categories desired. The punching of the cards or tape must be done in accordance with the codes used for the basic classifications for maintenance operations and also in accordance with codes which identify the work performed with respect to (a) where the work was done; (b) how the service was performed, that is, whether with labor, materials or equipment; (c) the dollar value of the service; and (d) where necessary, the quantity of the materials used or services provided.

With the source data in this detail, costs can readily be accumulated by control section, district, division or county, by route or system, by surface type, type of facility, traffic volume groups, maintenance activity, and for any other category required. Although this can be done on accounting machines, it can be done

much more rapidly on the computer and the results can be tabulated directly from the computer output cards or tape.

Perhaps the most valuable item in analyzing maintenance performance is the unit cost for doing a particular job on a measured physical element of a section of highway of known characteristics — the cost per mile for ditch cleaning, the cost per square yard for patching, the cost per acre or swath-mile for mowing, etc. In making cost analyses and in applying maintenance cost data to the evaluation of design and construction practices, such unit costs can be of much greater value if they are correlated with the characteristics of the control section on which the costs were incurred. For example, the trend in maintenance costs as a particular facility becomes older provides a basis for estimating the probable time at which major rehabilitation or complete reconstruction will be required. In the case of surface maintenance, correlation with traffic intensity, pavement design and subgrade characteristics is essential to reliable cost analyses. Similarly, for other maintenance operations, unit costs must be correlated with the factors or conditions which influence them to be of maximum utility.

Unit costs also provide a sound basis for the preparation of the maintenance budget. The maintenance work load for the year, known and estimated, both in total and by control sections, and broken down into specific maintenance operations, combined with applicable unit costs, gives a realistic performance budget which is compatible with actual work load and prevailing costs. Control-section data permit the suballotment of funds to the divisions or districts in amounts consistent with their maintenance work loads.

Such development of unit costs can be done on the electronic computer in a relatively short time without manual computation of any kind. The computer can also produce the maintenance budget (using basic maintenance work load records and estimates punched on cards or tape) and the computed unit costs (in the form of

punched computer output cards or tape) in a small fraction of the time required by manual methods.

The electronic computer can also be of considerable value in equipment cost accounting. Equipment cost includes all costs involved in providing and utilizing the services of equipment except the wages of operators. It is divided into three major components: direct costs, indirect costs, and depreciation.

Direct costs are those incurred in operating, servicing and repairing the equipment and are chargeable in full to the particular piece of equipment involved.

Indirect costs are those not identified with any particular piece of equipment — largely overhead items. These costs normally are prorated to all of the pieces of equipment affected.

Depreciation is a measure of declining value and is computed from a formula representing one of a number of arbitrary methods.

Direct costs are recorded from a variety of documents such as operators' reports, shop billings, receipts, and commercial invoices. Indirect costs are computed from central office records of the overhead costs involved. Depreciation is also computed in the central office.

From these basic cost figures, the information essential to efficient equipment management can be developed. Monthly and annual totals of equipment usage and costs can be compiled in practically any degree of detail required. These compilations, in addition to showing total costs, can be used to determine the effect of age on operating and repair costs for use in scheduling major overhauls and replacements; to determine the makes and models, as well as the individual units, for which operating and repair costs are disproportionately high; to detect areas in which equipment utilization can be improved; to maintain a proper balance between the equipment fleet and the maintenance work load; and to improve efficiency of operations by replacing obsolete and uneconomical units.

The same data can be used to establish and keep current equipment rental rates

for distributing equipment costs to the several activities in which it is used.

Equipment is used on various sections of road and for various maintenance operations so that its cost cannot properly be charged to any single section or operation. The usual practice is to distribute equipment costs by means of an equipment rental system which serves to channel items of cost into accounts maintained for individual units of equipment and then to transfer them to the road sections, projects or maintenance operations involved in the form of equipment rental charges.

The application of rental charges to equipment usage is a relatively simple procedure but the determination of appropriate rental rates involves hundreds of items of cost and a large number of computations, many of which are repetitive. There is not only the initial determination of a rental rate for each type and size of equipment but also periodic checking and revision as well so that the entire process is a continuing one.

As in the case of maintenance cost accounting the sheer volume of computation involved has discouraged the optimum use of equipment cost records. The electronic computer provides a means of greatly facilitating the analyses which can be made from basic costs and thus can serve as a valuable aid in equipment management. Depreciation and indirect costs chargeable to each piece of equipment can be quickly computed and the results automatically punched on cards or tape. These data, combined with direct costs manually punched on cards or tape, comprise the input data for tabulating monthly and annual cost reports and for making any analysis desired on the electronic computer.

Procedures can be developed so that no computation need be made in reporting or recording costs — all computations can be made by the computer both for maintenance cost accounting and for equipment cost accounting.

Since electronic computers are located in the central office, the use of the computer for these accounting operations

necessitates reporting all cost data direct to the central office. This has the advantage of concentrating all records in one location eliminating duplication of effort and facilitating use of the data. Computation and compilation at field office levels are eliminated.

Copies of tabulations and the results of analyses can be furnished field offices for their administrative needs. The speed with which basic data can be processed is another important advantage of electronic computation. For example, it will not be necessary to wait several months after the close of the fiscal year to determine which equipment rental rates should be revised to obtain a better balance between expenditures and earnings.

Another advantage is that analyses can be made with the electronic computer which previously could not be undertaken because of the volume of computation required. Perhaps one of the most valuable analyses which can be made from basic equipment cost data is the effect of age or usage on operating and repair costs. This is one of the basic considerations in determining whether the unit should be replaced rather than overhauled. Consideration can also be given to the increase in productivity available from a modern machine over the old machine.

The fact that equipment is not incurring excessive operating or repair costs does not always mean that the work on which it is used is being done economically. The equipment may be obsolete to such an extent that substantial savings could be achieved by turning it in on a new, more modern unit which has greater ability to produce. Productivity of equipment, as measured by the cost of performing a given quantity of work, is a phase of equipment management with which very little has been done because of the computing load involved.

These factors can be formulated for use in developing programs for performing such analyses on the electronic computer thus making possible factual determinations of equipment obsolescence and replacement needs.

The procedures and programs devel-

oped for maintenance and equipment cost accounting for state highway department operations can be extended to county operations. Not only would this be a very considerable help to the counties but it would also tend to develop uniformity in accounting procedures and in maintenance and equipment management procedures among the counties. It would provide additional basic data for use by the state in developing unit costs, rental rates, and performance standards.

This is a new area insofar as the use of electronic computers is concerned. However, a beginning has been made in a number of states. In Nebraska, computer programs have been formulated and are being used to develop reports on maintenance costs and equipment costs. These programs produce reports giving more up-to-date information than those produced on the punched-card accounting equipment formerly used and in about one-half the time previously required. The maintenance cost operations require about eight hours of computer time each month and give the following information:

1. A year-to-date summary card each month which gives the cost for each item of work by patrol section.
2. A year-to-date summary card each month which gives the cost for each item of work by surface type.

These cards can then be tabulated to give:

1. The year-to-date item cost in each patrol section.
2. The year-to-date item cost in each field division by surface type.
3. The year-to-date item cost by surface type for the entire state.
4. The year-to-date item cost by item for the entire road maintenance operation.

The equipment cost operations in Nebraska require about four hours of computer time each month for the entire system of about 10,000 miles, and produce a year-to-date summary for each unit of

equipment including the following information:

1. Equipment number.
2. Miles operated.
3. Hours operated.
4. Gallons of fuel used.
5. Quarts of motor oil used.
6. Cost of fuel and lubricants.
7. Cost of repairs.
8. Cost of special service.
9. Cost of tubes and tires.
10. Total cost of operation.
11. Rental earned.
12. Average cost per hour or mile for fuel and lubricants.
13. Average cost per hour or mile based on total cost.

In both cases the tabulations for the reports are made directly from computer output cards, thus eliminating manual handling.

In Maryland, programs are being developed for producing on the electronic computer equipment unit costs, average unit costs, departmental costs, and other statistics used in administering equipment operations.

Other states are planning or have actu-

ally begun the development of electronic computer programs for these purposes.

Although these are excellent beginnings, much more study and development is needed to obtain maximum advantage from the electronic computer in maintenance and equipment cost accounting. To this end, a joint task force has been established within AASHO, composed of members of the Committee on Uniform Accounting and the Committee on Electronics. The primary objective is to collaborate with the states in the formulation of electronic computer programs for highway department accounting operations, including maintenance and equipment cost accounting, which will be flexible enough for use in all highway departments.

This is an ambitious undertaking which will take considerable time to develop fully. However, if the task force is successful in achieving its objective, this will be another step forward in improving highway engineering and administration through the use of electronic computers.

REFERENCE

1. "Know Your Highway Costs," H.R.B. Special Report 13 (1953).