Abridgment

Birmingham-Jefferson County Transit Authority Maintenance Management Information System

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The way in which a computerized maintenance management information system has made a notable and favorable financial impact on maintenance labor cost at the Birmingham-Jefferson County Transit Authority is discussed. The paper identifies the need to which the computerized system was directed and presents a system overview of the elements of the system. It also shows how each element works and describes the achievements in financial terms of the maintenance management information system.

In recent years the demand for urban public transportation has been increasing. Furthermore, as a result of current changes in the cost and supply of energy resources, it can be anticipated that public transportation networks will need to be expanded in the future. The labor intensity of public transit operations means, however, that operating costs are significantly influenced by prevailing economic inflation. Accordingly, the cost of public transportation service in the 1970s has increased substantially. Faced with limited and reasonably predictable financial resources, transit management must be vitally concerned with the most effective use of these resources, particularly with regard to labor compensation and productivity. Much attention is usually devoted to the examination of labor requirements in the administrative and operational departments of a transit organization. At the Birmingham-Jefferson County Transit Authority, however, an examination of work activities and personnel requirements in the maintenance department proved very interesting. Indeed, the maintenance management information system (MIS) produced as a result of this examination has been instrumental in controlling costs and in improving the performance of daily operations. This paper briefly examines this maintenance MIS and reviews its potential application in other transit environments.

Maintenance labor usually constitutes about 25 percent of the total labor cost of a transit system. This cost element has perplexed many transit operators because of the general unavailability of qualified data supporting the expenditure. Most transit operating budget and control reports provide lump-sum expenditure calculations without any specific accounting for the accomplishments associated with this cost. When analysis is directed at these statistics, most transit managers can only develop broad generalities about the actual maintenance situation, thus leaving many matters subject to question and concern.

Maintenance activities, however, are not unique to the transit industry. Labor-quantifying techniques that are used widely in other industries, particularly in aerospace, automotive, and trucking industries, just have not been employed to any great extent in the transit industry. To a certain extent this practice may be excused by the recent history of the transit industry. Data processing is largely an outgrowth of the 1960s and 1970s, a period in which transit-management capabilities were not progressing rapidly. Although some data processing has been used in the transit industry, historically the emphasis has been on keeping records on parts rather than on labor. In the past, the parts expense was of serious concern to the transit manager, but now the labor dollar is of such serious concern that more-quantifiable control techniques demand development. The maintenance MIS developed by the Birmingham-Jefferson County Transit Authority is directed at quantifying the labor activities in the maintenance department. The main objectives of the system are to control overall maintenance costs, to develop specific maintenance costs per vehicle, and to provide documentation for the development of maintenance payrolls.

SYSTEM OVERVIEW

In greater detail, the Birmingham-Jefferson County Transit Authority maintenance MIS is designed to accomplish the following specific functions:

1. Determine the amount of time required to perform all tasks in the maintenance department;
2. Compute nonproductive time for each employee on each working day (nonproductive time is defined as the difference between time that has been accounted for and the standard 8-h workday);
3. Compute and store the average time required to perform each function in the maintenance department;
4. Measure the current elapsed time for each maintenance task and the average time that has been previously stored and require an explanation if the current performance exceeds stored average by a stipulated margin;
5. Account for all activities such as sick leave, vacation, holiday, personal time off, and jury duty;
6. Compute, by using the pay rate assigned per employee, the cost associated with each task and associate the cost with the job code, vehicle number, and the fare-account classification system;
7. Compute gross pay per employee in a form compatible with the payroll system;
8. Provide a job-code report that compares the performance of all employees on each activity and associates the activity with the vehicle, date, employee, elapsed time, average time, and explanation for excess time;
9. Provide the gross-pay report that computes gross pay for the entire period per employee in terms of straight time, overtime, and miscellaneous paid time;
10. Recap the gross-pay total into the fare-account classification system; and
11. Provide individual vehicle-maintenance reports that show all of the activities performed, date of such performance, employee performing such activity, amount of time expended and cost for each activity, and total cost per vehicle.

All of these activities were merely a means of providing better records about the activities of the maintenance department. The data-processing capabilities necessary to provide this information were readily available from software suppliers. The major problem encountered in implementing the MIS

program involved the instruction of the individual mechanics and supervisors in the use of the data-processing system.

ELEMENTS IN THE MAINTENANCE MIS

The Birmingham-Jefferson County Transit Authority maintenance MIS program requires active personnel to be familiar with the three key elements of the system discussed below.

Activity Code

Of utmost importance is the proper codification of all maintenance department activities. It proved to be particularly difficult to define activities so that everyone who used the program (including the director of maintenance, shop foremen, mechanics, bus hostlers, and janitors) has a mutual understanding of what each job code entails in terms of performance. It is extremely important to define the jobs in such a manner as to provide comparability. For example, "relining brakes" is not an appropriate job code; there are distinct differences in the time and effort required to reline front brakes rather than rear brakes or to reline brakes on different models of buses. Therefore, it proved necessary to define specific job codes for each type of brake assignment that could be encountered in the maintenance shop.

Considerable effort must go into developing the activity code or else no maintenance-labor performance standards can be developed. In Birmingham, the process began with the maintenance director and key maintenance personnel, who examined all sections of vehicle-repair manuals. Through this process, individual tasks were described and defined. These tasks were then reviewed extensively with operating foremen and mechanics to determine precision of definition. At the outset, the jobs described were, at best, somewhat tentative. After time and experience had been accumulated, additional modifications to the definitions were implemented. Allowance was made in the computer program for a high degree of flexibility in the job-code-definition process. This permitted a considerable degree of freedom in adding, deleting, and modifying job codes that experience had proved to be an important feature of the computer program. When job codes are developed and become operational, the codes are permanently stored in the data base of the computer program and are called forth simply by job-code number.

Time Cards

The time card is intended to capture all of the relevant information needed to run the system and to provide such tests of the information as are necessary to provide adequate verification with data stored in the computer. Certain information, such as employee name and job-code description, is stored in the master files of the computer. When the employee number is entered, the computer will respond with the employee name, which is compared by the operator with the name that appears on the time card. Similarly, when the job code is entered, the computer responds with the job description, which is compared with that written on the card. Vehicle number and fare-account code are similarly controlled. Date and base rate will apply to all future activities on the time card unless modified by the program operator.

The computer must have information regarding the completeness of the job in order to properly process the activity. Many times a job will be started in the morning, dropped, and picked up later in the workshift. The program is designed to accommodate these circumstances and has been modified recently to deduct 30 min of lunchtime from any activity on demand. This iteration in the program was included to avoid the necessity to punch in and out of a job-code activity simply because of breaks. Other features of the program permit a redefinition of pay rate whenever a mechanic performs an activity outside of his or her normal work classification. Furthermore, overtime work can be readily added to the system.

After all of the workday activities have been entered, the MIS program will automatically generate a nonproductive entry that charges the nonproductive job code the difference between the time the employee actually accounted for and the normal 8-h workday. This report provides documentation for review of employee performance by foremen and other supervisory personnel. The total posting time for the 52 time cards of Birmingham-Jefferson County Transit Authority's maintenance department requires approximately 2.5 h/day.

The Computer System

The program is written in BASIC, which is a readily transferable language. The program is processed by an HP3000 computer that has a cathode-ray tube (CRT) unit located on the premises and that is connected with a high-volume modem that is linked by telephone to the computer service bureau. The program can be operated by clerical personnel with minimal training. This limited training is in part the result of internal controls and the question-and-answer style of the conversational BASIC program. Specific features of the overall program are as follows:

1. The time-card loading program (a) provides date-validation, employee-verification, job-code-validation, and vehicle-number checks and balance with the fare-account coding system; (b) permits computation of total elapsed time for work performance and storage of jobs in progress; (c) automatically calculates work time for jobs delayed; (d) reports specific jobs that exceed average work time; (e) handles special calculations such as work time, including overtime, lunch break, and allotments; and (f) permits time-card corrections to be readily made.
2. The excess-time program requires an explanation to be entered on all activities for which excess time has occurred and automatically calls up work tasks that require such explanations.
3. The employee master program provides for the addition, deletion, and modification of employee names and numbers; requires the confidential code for access; and provides the capability to change rates for employee.
4. The fare-account master program provides for the addition, deletion, or modification of fare-account codes and descriptions.
5. The job-code master program provides for the addition, deletion, or modification of job codes and specific descriptions.

All of these key program elements are explained to every employee in the maintenance department. Once the program procedures are understood, operating employees need only complete daily time sheets to provide the necessary record-keeping capabilities. In this manner, the maintenance MIS program has had little or no influence on daily maintenance-work activities.

ACHIEVEMENTS OF THE MAINTENANCE MIS

The Birmingham-Jefferson County Transit Authority has been using this maintenance MIS for approximately a year. During that year, it has become apparent that data-processing efforts can be readily implemented at transit operating properties. The maintenance personnel in Birmingham have become quite familiar with the reporting requirements, and these requirements have had little adverse impact on daily work activities. In addition, the data-processing system has provided the type of information necessary for supervisory and management control of maintenance activities. Specific records on individual work performance, as well as detailed maintenance records for each bus, are available for analysis. Specifically, it would appear that labor productivity in the maintenance department has increased significantly as a result of these data-processing efforts. During a recent nine-month period, overtime has been reduced to one-third that of the similar period of the prior year. This productivity has improved not only because the employee is aware of the monitoring capability but also because of the additional training that has been focused on many employees. Evidence of results can be seen in the FY 1980 budget; maintenance costs were reduced to little more than 96 percent of the prior year's cost over a similar nine-month period, whereas other operating functions continued to experience double-digit inflationary increases.

Maintenance is a significant area of cost incurrence in the public transit industry. As transit operations continue to expand, further management attention must be directed to maintenance problems. In Birmingham, experience with data processing and analysis of maintenance labor requirements has yielded some tangible benefits. It is hoped that, by means of further analysis and review, additional cost savings can be identified and implemented.

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Work Sampling as a Performance Measure for Maintenance Functions

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The way in which two work-sampling studies were used as tools for objectively measuring activity levels in transit-vehicle maintenance shops is discussed. Positions ranging from utility worker to foreworker were sampled in four shops to determine how time was utilized, i.e., productively or nonproductively. The results of the studies are summarized and their implications examined. Improvements were found as a consequence of recommendations implemented after the first study; however, foreworker control over the work force was found to be insufficient in both studies. Increases in essentially nonproductive activities were attributed to decreased work load, and the issue of sufficient work load raised the possibility of adjustment of staffing levels. The data compiled from the work-sampling study were used to estimate the potential for reducing staff through attrition and transfer.

Managers in transit agencies today are vitally concerned with the effective use of their employees. Underutilized employees mean lower operating efficiency and, therefore, higher costs. Although they are not usually involved in direct labor supervision, managers are responsible for providing the necessary control to ensure that workers are fully productive and that costs are kept down. However, determination of the amount and type of control to apply requires that managers get accurate information on the work being done and on the effort being applied. Often the issue is how to evaluate fairly the feedback given by different supervisors and foreworkers on the performance levels of their employees. The question for managers, then, is how to objectively determine the amount of productive time that exists for various position classifications, shifts, and shops.

One prevalent method of objectively measuring productive time is a work-sampling study. The advantages of using work sampling for measuring people's activities are that

1. It is a widely accepted, low-cost, work-study technique;
2. Many positions or machines can be analyzed at the same time by one analyst;
3. People who have little technical background are able to do the actual sampling; and
4. Observations can be made over a long period of time so as to compensate for variations in the work performed.

One of the objectives of this paper is to familiarize the reader with the procedure of performing a work-sampling study. The other is to present an example of how work sampling can be used as a performance measure in maintenance shops.

STUDY OBJECTIVES, DESIGN, AND IMPLEMENTATION

As in any study, there are some basic steps a person must follow to successfully complete the analysis. The following description of the studies conducted at San Francisco's Bay Area Rapid Transit (BART) will outline the seven steps that constitute a work-sampling study.

Discover the Need for a Study

In 1976, BART was experiencing a car-availability problem. Shop management felt that the low number of cars released to revenue service was caused by low productive time in the shops. Since BART was planning to expand service, it was imperative that the car count be increased. Therefore, shop management decided that an objective work study should be conducted by the industrial engineering group that had just been formed within BART.

Define the Objectives

The purpose of performing the work sampling studies