Getting Control Over Operating Budgets: Methodology for Evaluating Productivity Alternatives

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ABSTRACT

Productivity improvements have become a key element in the struggle to preserve the integrity of transit service in an environment of diminishing public funding. The need for increasing operating efficiency through productivity improvements is not unique to transit operators in the United States. Transit systems in the United Kingdom are also being pressed to realize operating savings by reductions in funding from the central and regional governments. One agency, London Transport-Rail, has incorporated productivity improvement programs as a fundamental element of daily operations. In doing so, they have encountered a number of problems related to productivity project development, analysis, and control. These problems provided the impetus for conducting a study that developed a standardized process and analytic technique for preparing a productivity program. The methodology, detailed in this paper, allows for consistent analysis and evaluation of a wide variety of productivity tasks that require varying degrees of capital or operating expenditures, or both, and savings over incongruent time periods. The analytic technique is simple to apply and uses net present value analysis to compare diverse projects. The standardized productivity development process allows anyone in the organization to present a "good idea" for improving efficiency and provides a consistent evaluation of these ideas to facilitate sound decision making by top management.

Operating in an era of diminished public funding, transit agencies are pressed to find ways to reduce or constrain expenditure of limited operating dollars. Many systems facing severe financial constraints have already initiated substantial service reductions and fare increases to balance costs with available revenues. Although this response may be appropriate for averting an immediate crisis, it often serves to undermine transit's goal of meeting appropriate for averting an immediate crisis, it often serves to undermine transit's goal of meeting...
infusion of capital investment funds. However, because total funding for transport has been limited, a new approach for revitalizing the LT-Rail system was needed.

In May 1983 the LT-Rail directors approved their first comprehensive strategic plan. The plan committed LT-Rail to an ambitious capital program that would modernize and revitalize the huge underground rail system. The key to the program’s success was the more efficient use of capital funds and the reduction of operating expenditures to be achieved through new procedures and reduced staffing levels wherever possible. One area of obvious opportunity for reduced operating cost was the maintenance budget, which currently stands at $100 million ($130 million) per year in expenditures for maintenance activities. The plan required a reduction in this operating expenditure of 2 percent per year, or roughly $2 million ($2.6 million) per year, for 2 years. The challenge was to achieve this operating cost reduction while improving the condition of the infrastructure through judicious capital investment and maintaining the quality standards for which LT-Rail is famous worldwide.

Two types of initiatives are now being undertaken by LT-Rail to implement their approved strategic plan. The first is capital projects that are developed by a formal process conducted by dedicated staff, including financial evaluation and top management review and direction resulting in successful project implementation. The second set of initiatives is productivity tasks for maintenance and engineering functions. The objective of these tasks is to reduce the operating expenditure for rail maintenance through a wide variety of procedural, organizational, and operational changes. Departments are given targets in the strategic plan for reducing operating budgets and are directed to develop programs to reach those targets. Productivity options are developed by any number of staff members in a given department. Some options are a response to a visible problem (e.g., an equipment reliability problem), although most are the result of a “good idea” generated by someone who has identified a better (i.e., more efficient) way to perform existing functions. There are now more than 300 productivity tasks that were developed to reduce maintenance expenditure. The implementation of these tasks is under way and has contributed more than $2 million per year in cost reduction to date. The challenge is to keep these tasks progressing and contributing to operating cost reduction.

A system entitled value analysis was developed to assist the manager of each productivity task in the development and implementation of his productivity tasks. Many of these tasks require significant capital investment to achieve the operating expenditure reduction desired. Moreover, productivity tasks generally have alternative approaches that must be evaluated. All productivity tasks require review by several layers of the organization, including the line manager responsible for day-to-day operation, financial staff, and top management. LT-Rail’s experience in developing capital projects needed significant improvement to meet the ambitious objectives of the new strategic plan. The objective of reducing maintenance expenses required a new process that was efficient and easy to use for the managers involved and the reviewers. The resulting value analysis system, in both its manual and microcomputer versions, meets these objectives.

INITIAL PROBLEM

Although the response to the need for productivity improvements has been tremendous, several problems have occurred in comparing potential tasks and developing implementation priorities. The problems fall into three areas: the process, the analysis, and the documentation of productivity tasks. Each of these is discussed hereafter.

The approach to productivity task development is decentralized—virtually any staff member can suggest a potential improvement. The review and authorization of productivity tasks, however, are centralized and require that top management review each task. At the onset, there was no accepted standard for developing tasks or soliciting input into task development by affected parties. Poor communications in the initial proposal development process led to incomplete identification of alternative ways to implement a project and to interpersonal conflicts when affected parties were not consulted during proposal development. Further, the staff members responsible for developing projects did not fully comprehend finance department and top management expectations in terms of alternatives development, analysis, and documentation. Several engineers found the productivity proposal process to be frustrating and could not determine the criteria that the finance department used to evaluate projects. The staff members responsible for proposal development were becoming increasingly frustrated by the seemingly ad hoc productivity development and review process.

In addition to inadequate communications, the analysis of alternatives varied considerably among departments and individuals. Capital and operating costs (savings) were estimated at various levels of aggregation and accuracy. The time period required to implement programs, and realize the savings, was not typically considered in the analysis. Also, no indication of the relative accuracy or range of potential savings was shown in proposals. The result was that managers responsible for project authorization and cost reduction were comparing incomparable numbers to make key productivity decisions.

Another problem occurred in documenting projects. There was no accepted format for documentation and even the best projects often lacked sufficient documentation for authorization. Two common problems were that alternative implementation plans that were dropped during the analytical phase and relevant assumptions or constraints were omitted from the proposals. Frequently, reviewers would request that additional analysis be done on those alternatives already dismissed by the proposal author; this resulted in substantial delays.

The deficiencies inherent in the initial productivity development process, shown in Figure 1, led to substantial problems at all levels of the productivity program. The results included extensive delays in authorizing projects and failure to realize the maximum savings anticipated from many projects. Recognizing the shortcomings, LT-Rail and its consultant conducted a study to revise and standardize the productivity evaluation program.

PROJECT OBJECTIVE

The objective of the project was to develop a productivity process and analytic methodology that:

• Assesses capital, operating, and maintenance costs of productivity projects,
• Applies to capital investment, tactical (e.g., contracting out), and productivity proposals,
• Is consistent with and complementary to existing finance department principles and practices,
• Produces reliable and comparable results through consistent analysis of all projects;
FIGURE 1 Overview of initial task/project development process.

- Promotes effective alternative project identification and analysis; and
- Is easy to use and understand.

To satisfy these diverse criteria and address the problems identified in the review of existing procedures, a two-level approach to value analysis was formulated.

VALUE ANALYSIS FRAMEWORK

The analytical process and procedure developed to address LT-Rail's need was entitled "value analysis." The process consists of two levels, a preliminary and a final value analysis, as shown in Figure 2.

The value analysis methodology has several key features:

- Capital and operating cost and savings implications of engineering productivity projects are expressed in whole-life costs, or net present value;
- Generation of alternative implementation strategies is encouraged early in the process through use of a quick and simple level of analysis;
- Input from the finance department and other affected parties is solicited early in the process; and
- The value analysis technique serves as a standard to guide all productivity projects, thus ensuring consistent and comparable program analysis.

The preliminary analysis step is intended to develop many alternatives in brief detail without developing rigorous specifications for the task's operating characteristics. Aggregate cost estimates are developed for capital requirements and the impact on operating expenses. A simplified net present value analysis, which assumes an even annual cash flow, is performed so that alternatives can be compared and evaluated. The preliminary proposal is submitted for initial review by all affected parties and identifies the most promising alternatives for inclusion in the final analysis. Reviewers may pro-

FIGURE 2 Value analysis framework.
The preliminary value analysis focuses on developing and screening productivity task options. The analysis begins with the selection of preferred options that are arrived at by project review with the affected parties.

The preferred option specifications are detailed and comprehensive capital and operating cost savings are estimated. A net present value analysis is performed for each preferred option and incorporates implementation schedules for realization of capital and operating costs and ensuing cost reductions. The results are compared, a recommendation is developed, and a final proposal is written and submitted for financial commentary before authority is sought.

The financial commentary is currently a step in the existing procedure and acts as a check to ensure that the estimates are reasonable and the analytic techniques are acceptable. In this activity, the finance department serves as an "outside auditor" or watchdog over financial estimates. Following financial commentary, the proposal is submitted to top management for the authorization decision.

**APPLICATION OF THE PROCEDURE**

The value analysis procedure is applicable to virtually all types of capital investment, tactical, and productivity projects. By using net present value analysis, capital investment, tactical, and productivity alternatives can be equitably compared with each other to optimize the return of investment to the transit system. The procedure should be applied to all projects that realize both capital cost and operating expense or savings. It is particularly important to use the procedure with projects that have phased capital costs or uneven annual streams of operating expense or savings, or both.

However, the procedure does not necessarily apply to all projects. The procedure need not apply to projects that realize constant annual operating cost reductions without incurring capital expenses. An additional case in which the procedure may not be appropriate is when the cost savings of a particular project are relatively small (i.e., the level of effort required might exceed the benefit received).

Flexibility can be built into the procedure. The preliminary value analysis should be applied to all projects regardless of the magnitude of savings. However, a cut-off point can be established to avoid excessive work on minor productivity issues. The cut-off point could be a net present value or capital cost threshold that, if exceeded, would require application of the final value analysis step. If the threshold is not exceeded, recommendations would be developed from the results of the preliminary value analysis.

In the study for L4-Rail, a threshold of £25,000 for operating cost savings or a capital cost (savings) of £50,000, or both, was determined as having a significant impact on the organization. Below these thresholds only the preliminary value analysis is required. The full two-level value analysis is to be applied to all projects that exceed these cost or savings figures.

**PRELIMINARY VALUE ANALYSIS PROCEDURES**

The preliminary value analysis focuses on developing and screening productivity task options. The preliminary analysis commences with definition of a problem or need, or simply a good idea for doing things more efficiently. On the basis of the need defined, the task manager must develop options for meeting the need. The task manager can rely on his own ingenuity, assistance from affected parties, and knowledge of similar situations to develop an initial set of options.

Options are alternative approaches to solving productivity problems and reducing operating expenditures. They may involve a capital expenditure to achieve a greater operating expense reduction and involve an immediate or phased-in implementation schedule. Options can include technology investments, organizational change, incentive schemes, new production techniques, or procedural revisions. Any process can be considered an option at this stage of the analysis regardless of reasonableness or feasibility (qualitative measures of cost-effectiveness). The most obvious and common solution may not be the most cost-effective.

The process of option generation relies on the different engineering disciplines and experience, which often bring varying solutions and contributions. The process of developing options encourages the generation of the "bright idea" and unconventional approaches to problem resolution.

When options have been identified, the task manager proceeds to conduct the preliminary financial analysis, which is relatively uncomplicated and requires a nominal effort to apply properly. The operating savings and capital cost estimates are provisional in nature and are intended for option comparison and screening purposes. The preliminary financial analysis is guided by a series of standard procedures. The result of the preliminary analysis is an estimate of the net financial impact, and value range, for each option.

Options are then compared and evaluated by the task manager and the client. Evaluation should focus on both the financial and the nonfinancial implications of each option. The annual operating cost reductions, capital cost, and net present value provide a sound basis for financial evaluation. Anticipated impacts on organizational effectiveness must be considered and documented as well. The initial proposal and analysis documentation are completed and submitted for review by other interested parties (e.g., department manager and finance director).

The preliminary value analysis is intended to be an uncomplicated, but sound, financial evaluation of task options. The analysis is guided by four standard procedures:

- Capital cost estimation,
- Incremental operating cost/savings,
- Net present value calculation, and
- Initial proposal documentation.

Each procedure develops a specific element of the preliminary value analysis that, when completed, provides adequate documentation of the analytic result.

**Capital Cost Estimation**

The procedure for preparing the preliminary capital cost estimate assumes that all capital costs will occur in the first year of project implementation. High and low capital costs are estimated to define a value range. The specific requirements for estimating cost are as follows:

- On the basis of the options identified, major and ancillary equipment items are to be defined in
terms of quantity and unit cost, the product of which is total cost.

- Installation and site costs may be estimated using a single value amount (i.e., lump sum).
- Training and manuals may be needed for some task options. These labor and materials costs can be estimated in one lump sum.
- The preliminary capital cost estimate should include a single amount for the initial supply of maintenance materials and supplies (e.g., spare parts).
- Each capital cost area is summed for best and worst cases.
- The useful life of the equipment is required for net present value analysis.
- All sources should be listed and may include telephone inquiries to sales outlets, manufacturers' price lists, examination of similar projects, and previous experience.

The results of the capital cost estimate for each option are documented for inclusion in the net present value analysis and in the initial proposal.

Annual Incremental Operating Cost

The procedure for preparing the preliminary incremental operating cost/saving estimate is conceptually simple. The operating cost estimate represents the expected change in current annual operating costs if the proposed option were implemented. High and low estimates of the expected effect on revenue expenditures are to be prepared and recorded for each option. The specific requirements for estimating the change in revenue expenditures are:

- Direct labor costs are estimated on the basis of the change in the number of employees by position and average annual salary for each position.
- An estimate should be made for those elements in overhead expenses that vary with the number of staff employed or person-hours worked, and the variable overhead factor should be determined.
- Total labor expense/savings is calculated by summing direct labor costs for all positions and multiplying the sum by the variable overhead factor.
- The change in the cost of materials and services can be expressed as a lump sum based on past experience, or built up based on major elements (e.g., spare parts, utilities, paper and ribbons, bearings).
- The expected change in total expenses is found by summing total labor and materials costs.

The present value of the expected change in annual revenue expenditures is also calculated. Both best and worst case revenue estimates are analyzed as follows:

- The previously determined expected annual operating savings/expense is inserted.
- The analysis period is identified consistent with the longest useful equipment life if a capital expenditure is involved in any task option. If no capital expense is required for any option, the analysis period can be relatively short (e.g., 5 years). The same analysis period must be used for all options in a single task.
- The simple present value factor for an annuity is determined from standard annuity tables and must correspond with the analysis period.
- The present value of operating expense/savings is the product of annual operating expense/savings and the present value factor.

The results of the present value analysis and preceding steps are documented. The sources for each operating cost estimate are recorded. This will assist in answering reviewer comments and in refining the preliminary estimates in the final value analysis.

The net present value for a given option is defined as the sum of capital costs and the present value of the change in annual operating expenses over the effective life of the task. The procedure for determining net present value is simple and relies on estimates developed in the preceding two steps. The steps in the analysis are as follows:

- The mean of the capital cost estimate is found by summing the best and worst case capital cost and dividing by two.
- The mean of the present value of operating cost/savings is found by summing the best and worst case operating expenses and dividing by two.
- The net present value for best, worst, and mean cases is found by summing capital cost and the present value of operating expenses.
- The value range from the mean is found by dividing either best or worst case net present value by the mean and expressing the result as a percentage difference from the mean.
- The average annual operating expense/savings is determined by summing best and worst cases and dividing by two.

When the net present value of each option has been calculated, an evaluation of each alternative is performed and the initial proposal summary is prepared. The proposal summary includes which options are recommended for final value analysis.

Initial Proposal Summary

The initial proposal summary briefly presents an overview of the task development and analysis results, as shown in Figure 3. The key issues reported are:

- A brief summary of the problem, need, or objective that the task options try to address.
- The option or options recommended by the task manager for final value analysis or management approval should be noted. Reviewer recommendations are required as well.
- A summary of each option is to be recorded, including option title, mean capital cost, mean annual operating expense change, and mean net present value. The task manager is to fill in the comments.
section with a brief description of the option and any pertinent nonfinancial issues related to the option.

The initial proposal summary, with the documentation developed at each step of the preliminary value analysis procedure, is to be circulated to appropriate reviewers (e.g., department managers, client, finance director) to solicit their comments and suggestions.

**FIND VALUE ANALYSIS PROCEDURES**

The final value analysis is intended to be a detailed evaluation of a limited number of potentially beneficial options. It builds on, and refines, the preliminary value analysis. The documentation from the preliminary analysis will serve as the starting point for further option evaluation. The final analysis procedure is guided by four standard procedures:

* Estimate final capital cost,
* Estimate final incremental operating expense,
* Calculate final net present value, and
* Develop and submit final proposal summary.

Each procedure provides detailed documentation of the analysis and results. The information on cost/savings, tasks, and implementation schedules is to be of a quality appropriate for inclusion in operating budgets, formal cost estimates, and project implementation.

The approach requires a disaggregate cost/savings buildup with documentation on sources of estimates. The disaggregate procedure incorporates phased capital expenditures and lags in realization of operating expense reductions. The net present value analysis combines the lifetime incremental operating and capital cost/savings in a single amount.

**Final Capital Cost Estimate**

The final capital cost estimate is to be built up from individual line item categories (e.g., major equipment items, site costs). It is intended to produce a cost figure suitable for budgeting purposes, inclusion in a formal cost estimate, and revision of capital and operating estimates for productivity within the monitoring system. The analysis procedure begins with a review of the preliminary capital cost estimate and culminates with completion of the final capital cost estimate. A separate capital cost estimate should be prepared for best and worst cases when any significant degree of uncertainty exists in either quantity or cost elements of the estimate. In cases in which the option is well defined and the degree of uncertainty
is minimal, a most likely estimate alone will suffice. The specific procedures for final capital cost estimation follow:

- The major equipment items listed in the preliminary capital cost estimate should be examined and revised, as appropriate. The project manager should examine and refine the level of detail for line items (e.g., a finer breakdown of equipment items may be appropriate), the quantities of equipment by type, and unit costs, as needed.
- The site and installation costs should be reviewed and disaggregated, as appropriate. It is often easier to develop a more accurate cost estimate by examining individual cost elements instead of a single lump sum.
- The training and manuals cost, previously addressed as a lump sum, should be itemized to allow a better cost estimate. The number of person-days required in training and required training materials (e.g., manuals) may be an appropriate level of detail.
- The initial supply of materials should be refined, as needed. It may be appropriate to note major maintenance materials and supplies by category.
- The total capital cost is found by summing cost estimates for each element.
- The useful equipment life should be reviewed and revised, as appropriate. This figure is to represent the number of years the equipment is expected to be used and maintained in a cost-efficient manner. This may well be shorter than the total life expectancy of the hardware if at some point it becomes too expensive to maintain or too costly to operate.

The level of detail contained in the final capital cost estimate is the most significant difference from the preliminary capital cost estimate. In addition, capital cost phasing, or the capital cost realization schedule, is also valued in the final estimate. This is particularly important for projects with large capital costs that require new facilities and, therefore, take time for construction and for the procurement of equipment.

**Final Incremental Operating Expense Estimate**

The final incremental operating expense/savings estimate is to be built up from individual line item categories and should be suitable for decision-making and budgeting purposes. The analysis procedure begins with a review of the preliminary estimate. Like the capital cost estimate, the operating cost estimate must be time relevant; that is, if it requires more than 1 year to realize the maximum revenue saving potential (e.g., labor reductions through attrition or if annual operating cost reductions are expected to decrease over time), this must be reflected in the cost estimate. If any significant degree of uncertainty exists, best and worst cases should be estimated. The specific procedures for the final incremental operating expense estimation are as follows:

- Direct labor should be estimated by position and by the period when the savings/expense occurs. If a labor savings or expense occurs partway through the year, this should be indicated. The analysis should use 13 equivalent (i.e., 4-week) periods per annum as the basis for allocation of labor savings (i.e., an employee expected to leave the rail business after six periods would be indicated by multiplying one employee by 6/13 by the annual salary for that position to determine the annual cost reduction).
- Allowance should be made for those elements in overhead expenses that vary with the number of staff employed or person-hours worked. This should be done with the department's costing office.
- Total labor expense/savings is calculated by summing direct labor costs for all positions and multiplying the sum by the variable overhead factor.
- The change in annual materials and services costs should be itemized to facilitate an accurate cost buildup. Cost categories might include maintenance materials, office supplies, utilities, and fuel.
- Other costs should be estimated by item as well. An example of a cost in this category might be the cost of contracting out maintenance services or the use of a typing service.
- Total annual expense/savings is the sum of the previously mentioned operating expenditures.
- All quantity and unit cost elements should be accompanied by a source reference to ensure accountability.

Following these steps and recording the analyses, assumptions, and sources of data will result in documentation that supports project recommendations in the final proposal summary.

**Calculation of Final Net Present Value**

The net present value for a given option is defined as the sum of capital costs and present value of the change in annual operating expenses over the effective life of the task option. The procedure for determining the net present value is relatively straightforward, though somewhat repetitive. Information needed for the calculation is obtained from the previous final estimates of capital costs and incremental operating expenses. The procedure for calculating final net present value, shown in Figure 4, is as follows:

- From the final capital cost estimate, extract the capital cost by year. The first year is expressed in current dollars and all the remaining years are in present value terms as calculated in the estimate.
- From the final incremental operating cost estimates, enter the cost estimates by year up to the effective life of the project. Each amount is expressed in current dollars calculated in the estimate.
- Determine the simple present value factors from appropriate financial tables made available for the analysis, for years 1 to 20. To simplify the analysis, incremental costs/savings occurring in the year beyond the 20th year are treated as uniform annual amounts or annuities. Select the annuity present value factor to express the value of the annuities in the 20th year.
- Calculate the present value of annual incremental operating costs/savings by multiplying the simple present value factor. For years 21 and beyond, multiply the costs/savings by the annuity present value factor and then by the simple present value factor for a lump sum payment in the 20th year.
- Calculate the net present value by summing all capital costs and operating costs and then subtracting total operating costs from the total capital costs.

The results of the net present value should be documented, showing all steps taken, analysis period, and interest (i.e., discount) rate used. If best and worst cases are developed, net present value should be calculated for both along with the
mean net present value. A value range, which represents the percentage difference from the mean, should then be calculated and recorded.

**Final Proposal Summary**

The final proposal summary briefly presents an overview of the complete value analysis, from the preliminary value analysis through the final value analysis. The key issues reported are

* A brief summary of the problem, need, or objective that the task options are intended to address.
* The action recommended by the project manager for management approval, for authorization, or for both.
* The schedule recommended for implementation that should correspond to the schedule developed for the capital investment and realization of revenue savings in the analysis.
* A brief discussion of the reasons for recommending one option and rejecting other options, or rejecting all options in some cases.
* A summary of each option evaluated in the final analysis is to be recorded, including option title, capital investments, maximum operating expense change, net present value, and the value range (best and worst from the net present value).

The final proposal summary, shown in Figure 5,
FIGURE 5 Final proposal summary.

should be accompanied by all supporting documentation developed during the final value analysis procedure.

BENEFITS OF THE TWO-STEP PROCESS

The value analysis of options presents unique benefits to LT-Rail, Engineering. Before this technique was developed, the engineers responsible for developing proposals and performing cost estimates were unaware of the analytic techniques used by the finance department, such as net present value analysis. The procedure removes the mystery of financial analysis and demonstrates the simplicity of the net present value analysis technique. The finance department's work load is shifted to the engineers who are more knowledgeable about the impacts that new projects have on operating costs in their respective engineering disciplines. Furthermore, by having the net present value analysis performed by the engineers, the trade-off between capital costs and operating expense becomes more apparent to the personnel directly responsible for project implementation decisions.

Another benefit of the process is that more alternatives can be considered in developing solutions to productivity problems. The value analysis procedure screens alternatives and focuses the expenditure of resources on the most promising options—those with optimal net present value and highest return to the system.

The process is developed for line managers. The line managers are responsible for operating budgets and have been directed to achieve productivity improvements. The value analysis process generates implementation schedules during the final analysis that can be used to
Monitor project implementation and the achievement of scheduled efficiencies and develop better cost and schedule estimations for future project proposals.

The procedure improves the likelihood of authorization for proposals that change standard operating procedures, staffing levels, and job responsibilities. The procedure was conceived with direct input from the line managers, finance, and top management and recognizes that they are the users and beneficiaries of the procedure and its results. A user's manual and microcomputer program were developed for applying value analysis as a result of the study.

The value analysis procedure has been adopted by the LT-Rail engineering departments and is currently in use. The procedure has been successfully implemented, and productivity tasks evaluated using the technique are now in the implementation phase. The standardized value analysis procedure is contributing to more effective communications between staff engineers, finance, and top management. It is still too early to compare actual-to-anticipated savings estimated using the technique, but this should be known in the coming year as projects are implemented and monitored at LT.

CONCLUSIONS

Although the value analysis methodology for developing, analyzing, and reviewing productivity alternatives was devised to meet the specific needs of London Transport-Rail, it offers broad applications to transit operators in the United States. The impetus for developing a program of continued productivity improvements is apparent in both nations. Use of a standard productivity development, analysis, and review procedure offers transit agencies several key advantages:

- Ideas for improving productivity can be generated by line staff, clerical personnel, supervisors, or managers in any discipline and still be compared and analyzed on a consistent basis.
- Interaction and early communications with others encourage wider development of productivity alternatives and identification of different implementation strategies. Further, soliciting involvement of other interested parties may broaden support for productivity projects.
- Use of an uncomplicated analysis technique, like the one presented in this paper, takes the mystery out of financial analysis and the time value of money.
- Net present value can be used to compare productivity options that require varying degrees of investment of funds and energy and provide different returns over incongruous time periods on an equitable basis.
- The results of the value analysis provide a sound basis for decision making and define a plan for monitoring implementation and achievement of cost savings.

The value analysis technique, as presented herein, would require some minor revisions for application at other agencies. The primary areas of modification are the reviewing groups, the minimum threshold for a detailed value analysis, and decision-making authority. The sequential development and review process and the two-level net present value technique remain valid for practical application anywhere. Development of a productivity program, such as LT's value analysis, is a major step toward making efficiency improvements a cornerstone in the transit operating environment.

Improving Section 15 Passenger Data Collection Techniques

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ABSTRACT

The Urban Mass Transportation Administration requires all transit systems that receive federal funds to collect basic data on transit ridership. The transit systems are required annually to furnish estimates of systemwide passengers, passenger-miles, and, until recently, passenger-minutes under the Urban Mass Transportation Act Section 15 reporting requirements. Many transit operators have complained that the collection of Section 15 passenger data is an unwarranted burden. Modern statistical sampling techniques, however, provide the opportunity for somewhat reducing the effort required by Section 15. The specific objectives of this study were (a) to identify the range of techniques used by large transit properties to collect Section 15 passenger data and (b) to identify and evaluate improved techniques for collecting Section 15 data. A review of the literature showed little application of statistical sampling