Evaluation of Program Efficiency

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A^N EARLIER PAPER (1) showed the logic of a consistent approach to evaluating program effectiveness. This paper builds upon that logic to provide an approach to measuring program efficiency. The measurement of effectiveness and efficiency provides an evaluation of program performance.

Program Components

Programs include three components—objectives, activities, and resources, which were defined in the earlier paper as follows:

1. Objective. A situation or condition of people or of the environment which responsible program personnel consider desirable to attain. (Objectives themselves include ultimate objectives, program objectives, and sub-objectives.)

2. Activity. Work performed by program personnel and equipment in the service of an objective.

3. Resource. Personnel, funds, materials, and facilities available to support the performance of activity.

A program objective is distinct from a program activity; the term "objective" refers to a

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Whatever mechanisms or approaches are used in planning a program, the administrator needs to make three major kinds of decisions after specifying the problem toward which the program is to be directed. These decisions comprise (a) a determination of the program objectives and sub-objectives deemed necessary and sufficient for attaining the program objective, (b) a selection of one or more activities believed to have a high probability of resulting in attainment of each sub-objective, and (c) a determination of the kind and amount of resources needed to support the performance of the planned activities. In attempting to implement a program plan, an ideal plan will frequently have to be modified on the basis of extant constraints. Resources may not be sufficient to support all desired activities, or limitations of personnel may make it impossible to undertake certain desired activities. In such instances, modifications must be introduced to restrict the level of activities and perhaps the scope or breadth of the program objective. The logic of program operation is to expend resources to support the performance of activities and thereby to attain sub-objectives and the program objective.

Evaluation of Effectiveness

In general, questions concerning effectiveness are directed toward assessing the extent to which a planned or intended objective has been attained as a result of program activity. An analysis is thus suggested in which the proportion of attainment of the program objective that is attributable to program activity (AO) is compared with the desired level which, during the planning process, the planners had proposed would result from the program activity (PO). The earlier paper describes methods for discounting any apparent attainment that actually results from events other than program activity (1).

Program effectiveness is denoted as the ratio AO: PO, and this ratio is the only legitimate measure of program effectiveness. However, to interpret results properly—that is, determine the soundness of the assumptions on which the program is based-two subordinate measures of effectiveness need also to be considered. The first is the extent to which an activity has been performed as planned as a result of utilization of resources, in other words, the ratio of the actual activities performed to the planned activities scheduled to be performed—AA:PA. The second measure is the extent to which the resources have been expended as planned, that is, the ratio of the actual expenditure of resources to the planned expenditure, or AR: PR.

These two subsidiary measures are important since the program logic holds (a) that program objectives will be attained only if the activities have been performed both in the amount and quality planned, and (b) that activities will be performed only if the resources have actually been used as planned. Comparisons among the three ratios AR: PR, AA: PA, and AO: PO may show that the resources and activities that it was anticipated would be needed were either overestimated or underestimated. At any rate, the important point is that the measure of program effectiveness, AO: PO, as well as the subordinate measures of attainment of planned resources and activities, requires a comparison of the actual attained status of any one program variable with the planned status of the same variable.

What has been said about evaluating the attainment of objectives applies also to evaluating the attainment of sub-objectives. Effectiveness in achieving each sub-objective can be assessed by computing the ratio AOsub: POsub. By considering the activities and resources allocated to each particular sub-objective, one can also compute AAsub: PAsub and ARsub: PRsub and thus obtain measures of the effectiveness of the activities and resources associated with a particular sub-objective.

The earlier paper provides details and examples of evaluations of program effectiveness.

Evaluation of Efficiency

If the attainment of objectives were considered desirable regardless of cost and if unlimited resources were available for health programs, efficiency would not be of great concern to administrators. Since neither of these conditions obtains, however, efficiency must be a concern in program operation.

A definition of efficiency in public health programs may be formulated by referring to the classical definition of physical efficiency-the ratio between the energy output of a machine and the energy input supplied to it. In public health programs, efficiency may be defined as the ratio between an output (net attainment of program objectives) and an input (program resources expended), or AO: AR. The inverse of this ratio, which would be AR: AO, yields a measure of average cost. Clearly it matters little in public health programing whether one examines efficiency or average costs, since the same relationship will emerge. However, it is sometimes more meaningful to look at one than the other. For example, it is easier to understand that it costs \$10,000 to locate and cure one case of a particular disease than that 1/10,000 of a case was located and cured for \$1. (This situation is not true in physics since the units of comparison-energy-are the same in both the numerator and the denominator, and maximum efficiency cannot exceed 100 percent because of the law of the conservation of energy. In instances, however, in which the numerator and denominator consist of different units, for example, of objectives and resources, there is no theoretical basis for estimating maximum possible efficiency, and the terms can be either numerator or denominator.)

The measure of overall program efficiency AO: AR or AR: AO may be interpreted by examining two intermediate efficiency measures, namely, the relationship of activities to objectives and resources. Specifically, efficiency studies may answer questions about the relationship (a) between the extent of attainment

Key to Abbreviations	
AO-Attainment of objectives that can be attribut	ed
to the program activity	
PO-Proposed objectives for attainment throu	gh
the program activity	
AA—Actual activities performed	
PA-Planned activities to be performed	
AR-Actual resource expenditure	
PR-Planned resource expenditure	

of objectives and the resources expended, (b) between the extent of attainment of objectives and the number and kind of activities conducted, and (c) between the number and kind of activities conducted and the resources expended.

The ratio of program effectiveness, as indicated earlier, reflects the relationship between two estimates of the attainment of program objectives—the planned attainment and the actual attainment. And each of the two subordinate ratios of effectiveness involves similar comparisons of activities and resources. Program efficiency, on the other hand, reflects the relationship between two different variables—objectives and resources. Two subordinate efficiency measures also compare combinations of different variables. Three efficiency, or average-cost, ratios can thus be stated as follows, one for each of the foregoing questions:

1. Objectives attained to resources expended =AO:AR or AR:AO.

2. Activities performed to resources expended=AA: AR or AR: AA.

3. Objectives attained to activities performed=AO: AA or AA: AO.

Of course, each ratio may also be computed for the portions of the program related to each sub-objective. As is true for effectiveness, consideration, as the program progresses, of the efficiency with which the plan is being carried out may demonstrate a need for modification of the original plan.

Relation of Effectiveness to Efficiency

In the typical program setting, the administrator attempts to obtain an acceptably high level of attainment of objectives at minimum cost (that is, to maximize attainment at a fixed level of resource input or to minimize resource input at a fixed level of attainment). However, a proper interpretation of efficiency requires a measurement of activity so that two subordinate efficiency ratios, AO: AA and AA: AR can be computed. Consequently, as a comprehensive evaluation of performance, data should be obtained on all three components—use of resources, performance of activity, and attainment of objectives (including sub-objectives). Measures of effectiveness must be obtained before measures of program efficiency can be interpreted meaningfully since, from the definition of efficiency, knowledge is required of effectiveness as well as of resources.

Unless the administrator is satisfied with effectiveness, studies of efficiency will be uninterpretable or misleading. A person cannot decide that a program with an efficiency ratio of two units of attainment per unit of resource is superior to a program with a ratio of one unit of attainment per unit of resource unless he has knowledge of the effectiveness of each program. For example, suppose that two programs have the same objective. Program A attains all of the objective at a given cost, whereas program B attains half of the objective at a quarter of the cost. Program A is thus twice as effective as program B, but only half as efficient. Which program is superior? A rational answer can only be based on knowledge of both the effectiveness and efficiency of each program.

The attainment of sub-objectives and of the program objective cannot be measured, of course, until some time after a program has been in operation, but other valuable information can be collected earlier. It is always desirable to collect data periodically on progress to insure that a program is being carried out as planned. If it is not, adjustments can be made in the course of operating the program.

Typically, continuous evaluative measures can be obtained in the following sequence:

1. The extent to which resources are being expended as planned (AR:PR).

2. The extent to which activities are being performed in the quantity and quality planned (AA:PA) and the efficiency of resource expenditures (AA:AR).

3. The net attainment of selected sub-objectives (AOsub: POsub) and the efficiency of subobjective attainment (Osub: Rsub) and (Osub: Asub). 4. Program effectiveness (AO:PO), program efficiency (AO:AR), and activity efficiency (AO:AA).

If data on the first three of these evaluative measures are obtained early in the program operation, these data can provide a rational basis for changes in the program that may materially improve its effectiveness and efficiency. The only true measure of the effectiveness of a program, however, is the ratio of attained objectives to planned objectives, and the only true measure of efficiency is the ratio of attained objectives to expended resources. Therefore, for a comprehensive evaluation, the fourth evaluative measure must be applied.

Special Measurement Problems

We gave considerable attention to the measurement of objectives and sub-objectives in the earlier paper. Little was said about the measurement of activities and resources.

Since any program variable includes quantitative and qualitative components, we believe that measures of variables must reflect both dimensions. In most instances quantitative measures alone do not provide a sufficient basis for judging how adequately a program component has been implemented. Rarely are there no qualitative differences among a class of objects or actions. The dollar seems to be an exception since any one is equal to another in terms of a program's buying power at a single point in time. Similarly, constancy of quality is probably fairly closely approached by many standardized medications and vaccines, although mishaps occasionally occur. Few problems of measurement arise when we deal with highly standardized variables.

Generally, however, an assessment of quality as well as of quantity is desirable in program evaluation. When resources are described in terms of a given number of "qualified" physicians, nurses, or sanitarians or a given number of "adequate" clinic facilities, the extent to which the resources actually fulfilled the qualitative as well as quantitative requirements has to be determined. How many physicians, nurses, sanitarians, or clinics were provided and how qualified or adequate was each? When activities are described in terms of numbers of nursing visits, sanitation inspections, physical examinations, or educational efforts, the qualitative as well as the quantitative aspects must be specified and subsequently measured. We have to measure not only the number of activities but the extent to which each was performed on the desired level of expertness.

At present no ready procedures are available for developing and applying qualitative measures; we can only point out that qualitative measures are necessary. It is desirable for program personnel to bear in mind that effectiveness and efficiency are influenced as much by the quality of resources and activities as by the quantity. In some circumstances, the program administrator and his staff will be able to work out their own systematic measures of the quality of selected factors and will thus be in a better position to evaluate overall program performance.

Use of Data on Efficiency

The major concern of the administrator obviously is to attain a desired (usually high) level of accomplishment of objectives at a minimum cost. As indicated throughout this paper, a concern with program effectiveness logically precedes a concern with program efficiency. After the desired levels of accomplishment of objectives are attained or maintained, an assessment of the program's efficiency then becomes of prime concern. The administrator who knows how effective and efficient his program is can then judge whether its results are worth the cost.

We have implied that evaluation always entails comparison with a standard. In evaluations of program effectiveness, the standard for comparison most frequently selected is the attainment level that had been planned before program implementation began. A similar standard may be used for determining efficiency. One may ask whether the actual level of efficiency or the average costs are similar to what had been planned. It may have been planned that each unit of attainment would cost, say, \$100. An evaluation of efficiency may show that, in fact, each unit of attainment cost \$104. A program operator might then decide that the actual efficiency was so close to what had been planned that extra attention was not warranted.

On the other hand, he might conclude that the disparity between the planned and the actual efficiency was great enough to require additional analysis. The operator could then ask whether the planned efficiency of the resources or of the activities had been in error, and he would then attempt to revise the program planning accordingly.

Frequently, no sound basis for estimating planned efficiency is available, for example, in instances in which little or no evidence can be obtained about how many resources are required to support an activity or about the number and kinds of activities that will be required to attain an objective. In this situation, another standard for comparison needs to be selected. One that is frequently used, but a dangerous one, is the operation of the same program in an earlier year. Costs and circumstances may vary so from year to year that conclusions drawn from efficiency ratios obtained in two different years may be invalid. Nevertheless, with a knowledge of local circumstances and the costs of living, a person may be able to estimate from data obtained periodically whether efficiency is increasing or decreasing. The important point is that a comparison of the actual operation of a program with a reasonable standard permits a judgment as to whether the efficiency attained is satisfactory or unsatisfactory.

An administrator may be satisfied with the effectiveness of a program and still believe that its efficiency is unsatisfactory. Attempts to improve program efficiency require consideration of the subordinate efficiency measures A : R and O: A for each sub-objective and for the program objective. For example, studies may be made of ways to improve resource efficiency (A: R) by obtaining more or better activity, or both, from a given expenditure of resources. This ratio is the one being considered in speaking about the cost of a nursing visit or a sanitation inspection.

Use of a multiple-antigen immunization material in a broad communicable disease control program may be an example of improving the efficiency of an activity (O:A). In this instance, an equal or greater attainment of objectives may be accomplished as a result of a given amount of activity (thus, immunity to several diseases may be brought about from one series of inoculations). Of course, in such circumstances, resource efficiency may increase.

When program effectiveness is lower than desired, the administrator has four choices. One possibility is to reduce the desired level of accomplishment to the level actually attained. This choice might be suggested by the belief, perhaps bolstered by new data, that the observed attainment, although less than that desired, is the most which can reasonably be achieved given existing constraints. When new program objectives are set at current levels of attainment, studies of efficiency will be more useful in planning for subsequent program operations.

A second choice available to the administrator who is dissatisfied with his attainment is to decide, on the basis of his evaluative data, that he needs to increase the number or improve the quality of the activities directed toward subobjectives and objectives. Any such change will have implications for resource allocation and may thus be planned more rationally with the help of information on efficiency, namely, on the current ratios between activity and cost and between objectives and activities.

A third possibility is that the administrator will maintain the original program objective but, on the basis of evaluative data, decide to make substantial revisions in his program theory, that is, he will specify, and work toward, some new sub-objectives. In such an event, study of the efficiencies associated with the achievement of each sub-objective to be retained in the new program will aid in planning the subsequent operation of the program.

A final choice might be to abandon the program, especially if evaluation shows that it is low in efficiency and if pressures are being generated internally or externally to allocate the existing resources to other programs.

Limitations of Measures of Efficiency

One limitation on the usefulness of efficiency studies is that efficiency may not be constant at different levels of program operation. Consider a program objective to eliminate all of a given community problem. If a given input of resources and activities has eliminated 60 percent of the problem, it is not certain what returns could be expected from different levels of input. At the upper limit, doubling the resources and activities could not eliminate more than 100 percent of the problem. On the other hand, allocating exactly half of the resources and activities probably would not eliminate exactly 30 percent of the problem, but rather might eliminate 20 or 40 percent. It seems reasonable, on the basis of experience, that the expenditure of very limited resources will have little impact (low efficiency); increasing the resources will have a proportionately greater impact (higher efficiency); and finally, greatly increasing the resources will result in only a little more gain (reduced efficiency). This notion is illustrated in figure 1.

A leveling off in efficiency can be expected to occur when a program approaches complete attainment of its objective or when the greatest effectiveness possible from the types of activities performed has been attained. If the curve shown in figure 1 were known for a particular program, then an efficiency curve such as the one in figure 2 could be constructed. Thus, we would expect increasing efficiency with increased expenditures, but only up to a point; thereafter, the efficiency level would fall. will not tell the administrator at what point on these curves his program lies. But, if the point could be determined, such knowledge would have important implications for the planning of subsequent programs. If an administrator knew what the correct shape of the curve in figure 1 would be for a given program, he would know what proportion of the objectives could be attained with varying amounts of resource expenditures. If the current level of program attainment were at point B on the curve, obviously increased expenditures would not increase the attainment markedly; whereas increased expenditures for programs that begin at point A would have a great impact on the attainment of objectives. On the other hand, if the amount of resources that could be directed toward the program objectives were fixed, the administrator would know what proportion of the objectives might be attained and thus could judge whether the program was likely to be worth the effort. For example, if only enough appropriations were available to accomplish the objectives at point A in figure 2, the administrator might decide to invest his resources in a different program in which the same financial

A single evaluation of program performance







Figure 2. Hypothesized program efficiency at various levels of resource expenditure

Resource expenditure

allocation would permit greater attainment, or he might decide to go ahead with the original program if the problem being attacked was deemed to be worthy. In any event, knowledge of the efficiency curve would permit greater rationality in program planning.

Constructing Efficiency Curves

One way of constructing an efficiency curve would be for the administrator to subdivide the jurisdiction of the program and operate it at different levels of resource input in each subdistrict. (Controls to assure that the subdistricts were similar would be essential.)

A second way of constructing efficiency curves would be for a State or the Federal Government to arrange to operate, in similar communities, programs whose levels of operation are systematically varied. In such experiments, effects of previous program operation on the subsequent operation would be overcome. We would still be left, however, with the question of how far this knowledge would be applicable to future programs operating in constantly changing contexts.

How precise the prediction of future outcomes that will probably result from various resource inputs into a program will be depends in part on the composition of the target audience for the program. In some programs, the target audience changes from planning period to planning period; in others, it remains essentially the same. For example, consider a program directed toward increasing the proportion of seat belt users among the entire population of a community. The members of this population will change somewhat from year to year; all will age, some will migrate, some will die, new drivers will be added, but in large measure it will contain the same people from one year to the next. A seat belt program directed to the driver education courses for the community's 10th grade classes would affect a new set of persons each year, except for the few students who might repeat the course.

For target populations that comprise essentially the same people from year to year (such as all people in a community, the mothers of school age children, restaurant operators), past programs may have considerable influence on the results of future operations. In programs like those represented in the first seat belt example, efforts expended in the first few years of their operation may succeed in influencing all members of the target population who are predisposed to act while most of the remaining members resist all the subsequent efforts undertaken to influence them.

In programs such as the second seat belt example, that is, those in which potential clients come from a "new" population each year, similar outcomes from similar inputs would be expected from one year to the next if allowance is made for changes in the costs of living and other variables whose effects can be estimated.

Application of Methods

Application of the methods described here to real program situations will be fairly simple in programs in which resources, activities, and outcomes can be readily quantified in reasonably meaningful terms and in which the measure of attainment is consequently fairly straightforward. For example, the meaning of regular use of a seat belt is conceptually clear, although ascertaining actual achievement might require considerable ingenuity.

Such simple situations, however, are not common; more often program objectives are lacking in conceptual clarity. When a program director thinks in terms of raising the level of health in a group, he is dealing with ideas that may have no common meaning among a group of experts. One director may think of the absence of certain symptoms, a second thinks of certain physical signs, a third of emotional stability, a fourth of physical vigor, and a fifth of individual productivity. Others will think in combinations of several or all of these ideas. Before the program director can prepare an index of accomplishment, he has to specify the objectives he is going to try to measure, and this task proves most difficult in many health programs.

Similarly, in most settings, the conceptual meaning of the performance of an activity as planned is unclear. What is really meant by a "nursing visit" or an "inspection"? How, specifically, is the nurse or sanitarian expected to behave? When a person's role is termed "educational," what precisely is meant by education? Until one can specify, first in terms of concepts and then in terms of measures of quantity and quality, how the professional should behave in a particular situation, evaluation cannot be comprehensive, and programs cannot be systematically improved.

Conclusions

The tools described in these papers for evaluating effectiveness and efficiency are most useful for programs in which (a) the objectives have been specified qualitatively and quantitatively and have been fixed in time to particular geographic areas and to particular target audiences, (b) the programs are described in sufficient detail to permit reliable observations of performance of planned activity, and (c) all the resources that are directed toward program activity are identified.

Thus, the first step in evaluating effectiveness and efficiency appears to be to attain conceptual clarity about what the program is and what it contains. Then evaluation becomes straightforward.

REFERENCE

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