AN ESTIMATION OF ATTAINABLE IDEAL STANDARDS

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I. INTRODUCTION

Accounting data have been used both for palnning and control processes of a firm, which are two fundamental tasks of management. In general, the planning processes include to set operational goals or sub-goals together with means of achieving them. The control processes are the processes which attempt to ensure that plans are developed and carried out so that the likelihood of the goals being achieved is maximized.

As a business enterprise grows in size and complexity, the planning and control processes become more important and there has been a steady pressure on the development of more effective ways of planning and controlling business operations.

One of the means in achieving the effective planning and control for an operation is to provide more relevant and useful information for the planning and control processes. Traditionally, accounting has been the major

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source of management information and, specifically, managerial accounting has provided data for the planning, control, and internal performance evaluation function.

But, in the traditional accounting system, the accountant maintained operating activities, summarized and verified data and served as the primary information source for all decision makers. Under these situation, the users of accounting information had their needs satisfied generally as the consequence of accounting definition provided by others or restricted by the limits of the financial data. In the context of planning and control, those accounting information was not designed for planning purposes nor necessarily for measuring performance against organizational objectives.

The goal of this study is to provide a contribution to knowledge of cost accounting for providing more useful information in the planning and control process of management. Since it is not practical to deal with problems stemming from different types of organization, the study is confined to a certain types of organization, i.e., operationally homogeneous decentralized organization, which is defined later.

The first part of the study review definitions of control, function of cost planning and control, and behavioral aspects of cost conttrol, and behavioral properties for standards. In the second part the types of organization which the study is concernded is specified, and a quantitative model are described, which provide accounting that was not available in the past.

1. Definition of Control

A survey of the management and accounting literature seems to difine control as a process that guides activity toward an established goal or plan. The control concept can be further explained as follows.

(a) The first phase is to set standards that represent desired performance or the adoption of an operating plan.

(b) The second phase is a comparison of actual results with standards or the plan.

(c) The third phase is the analysis of operating variance, planning and corrective action. Control measurements and reports serve little purpose unless corrective action is taken when it is discovered that current activities are not leading to desired results.

2. Cost Planning and Control

As cost accounting has evolved from the study of the methods of recording costs and evaluating inventory for financial statement to the use of cost data for managerial decision-making over the past years, cost control became important. In general, a cost control system will function as tools for (a) control and reduction of cost, (b) cost planning, (c) motivating employee for more effecient performance, and (d) cost performance evaluation.

Furthermore, the delegation of the authority and the responsibility to a department or an operating unit by the top management creates a decentralization of decision-making in a modern firm. Under decentralization, operating units of the organization have control of specific resources and are responsible for efficient performance of the assigned operation. When a manager of a decentralized unit has the authoruty and the responsibility for an operation and its costs, each unit may be regarded as a cost center, for cost control purpose, defined as "the smallest segment of activity or area of responsibility for which costs are accumulated."(1)

Thus, for cost control purpose, each decentralized unit is the locus of cost planning, cost accumulation, and cost control and should therefore be evaluated, in part, according to their efficiency in cost performance.

As a special from of decentralization, some organizations consists of several operating units which perform same activity with same or similar

(1) Hongren, C.T., Cost Accounting, Prentice-Hall, Inc., Englewood Cliffs, N.J., 1967, p.69.

technology.[2] When those decentralized units have the authority and the responsibility for the assigned operation and the costs, each unit can be also considereda a cost center for cost control purpose and effective cost planning and control for those cost centers become extremely important. In this particular case, the problem of cost control is unique in the sense that all the decentralized units perform the same production activity. If we can design a cost control system that is applicable to the production activity performed by the decentralized units, all the units can use the uniform cost control system. The main advantage of having a uniform cost control system that are applicable to all the decentralized units is that the performance of the units can be evaluated on the basis of a unique criteria.

In short, as the management decision-making and the operations are more decentralized, better techniques of cost planning and control is needed to increase the ability of management to exercise control over performance. It is clear that a proper cost control system can perform the very vital and sensitive tasks of communicating information on the objectives to be accomplished, providing a standard for motivating efficient behavior and finally providing means for the evaluation of performance, learning and instigation of remedial action.

In the design of cost control system, the following two characteristics are frequently discussed; (a) first, the behavioral aspects of cost control, which stems from the interpersonal relationship and individual behavior in organizations. It was felt that the design of a cost control system should be based on behaviorally sound ground to perform properly the sensitive tasks of communication with and motivating the individuals responsible for the activity. Behavioral properties for sound control system are specified and discussed, (b) second, the determination of standards which satisfies the behavioral requirements are discussed. It includes the problem of measuring

(2) In this study, technology is defined as the industrial arts which exclude managerial and other organizational aspects.

the activity and review of prior researches in this area to search out the research questions in the study.

3. Behavioral Aspects of Cost Control

Considering that people are the most important elements of business operation, control can be thought of as a process that guides activities of people toward an established goal or standard. Under this concept, the human elements are the central focus of a control system and the importance of the interpersonal relationship and human behavior in organization should be recognized in the design of any control system.

In the traditional cost control system, actual results were compared with standard amount that represents goal for management, but the traditional approach generally overlooked the impact of control system on human behavior until recently. Thus, the traditional cost control has been criticized that "management may gather information on discrepancies and attempt to restore conformance to standards.... It is the individuals in the organization who actually exercises control... who accept or reject standards, who does or does not exercise care in the performance of his duties, or who accepts or resist efforts to change his behavior to achieve some objective or goal."(3)

It has been recognized further through behavioral research that once a cost control system is accepted or considered legitimate by individuals, the control system may serve as a motivating device to encourage improvement in performance and to accomplish the objective by voluntary adjusting their behavior to correct deviations from standards they accepted. On the other hand, the imposition of unaccepted or illigitimate standards may face resistence from individuals who also use creativity and energy in circumventing the unaccepted standards.

The adoption of standards is the first phase of the cost control process

(3) Miles, R. and R.C. Vergin, "Behavioral Properties of Variance Control," *California Management Review*, V. 8 No.3 (Spring 1966), p. 58.

and it includes the specification of standards and communicating the standards to the individuals responsible for its accomplishment. Although the behavioral problems may arise throughout the three phases of control, it seems that the problem is vital in the first phase of control, the determination of standards, because the complex behavioral problems tend to arise whenever the individuals whose performance is being evaluated considers the standards unreasonable.

4. Behavioral Properties for Standards

A control system not only should have the technical exellence in measuring and maintaining performance but also should take into considerations for the implication of human behavior on control.

A survey of behavioral researches seem to prescribe the following behavioral properties for a sound control system, as summarized by Miles and Vergin.(4)

(a) Standards must be established in such a way that they are recognized as legitimate. This requires that the method of derving standards must be understood by those affected, and that standards must reflect the actual capabilities of the organizational process for which they are established.

(b) The individual organization member should feel that he has some voice influence in the establishment of his own performance goals. Participation of those affected in the establishment of performance objectives helps establish legitimacy of these standards.

(c) Standards must be set in such a way that they convey "freedom to fail." The individual needs assure that he will not be unfairly censured for an occasional mistake or for variations in performance which are outside his control.

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(4) Miles and Vergin, *op, cit.*

(d) Feedback must be expanded. Performance data must not only flow upward for analysis by higher echelons, but they must be fed back to those directly involved in the process who will evaluate their own performance and may initiate corrective action.

On the basis of the above requirements for behaviorally sound control system, the following features of standards are believed to be necessary in the determination of standards.

(a) "Attainable Standards"; The standards may be classified into (i) the attainable ideal standards which represent performance levels that are considered highly or most efficient under normal conditions, (ii) the attainable normal standards which reflect the average performance under normal operating conditions over a period of time, and (iii) the theoretical ideal standards which represent the best possible performance theoretically.

There has been much discussion in the accounting literature as to which standards should be used. In general, for purpose of controlling performance, the attainable ideal standards are preferred to the theoretical ideal standards, because, unless the attainable ideal and theoretical ideal standards are coincident, the attainable ideal standards reflect the actual capabilities of an organization under normal operating conditions. The attainable ideal standard is a realistic standard for improvement of performance.

The attainable normal standards would provide a basis both for realistic short run control and planning of operation. On the other hand, the theoretical ideal standards would provide useful information for future planning in deciding what might be done to improve the present operations.

In this research, the study will be focused on the measurement of both the attainable ideal standards and the attainable normal standards, which are the ones that a process or an operating unit is normally capable of accomplishing under normal conditions. These standards are the attainable and realistic ones that would promote their acceptance by the individuals in an organization.

(b) "Scientifically predetermined"; The attainable standards must be based on scientific analysis. Any standards which are arbitrarily determined are more likely to face resistance from organization members. A measurement technique may be called scientific if it yields consistent, unbiased standards with least variability.

(c) "Range Estimates" of standards; The traditional cost control approach has used point estimates of standards, i.e., establishing absolute, inflexible performance standards. The main criticism on the absolute, inflexible standard is that it does not explicitly take into account the variation of performance by chance causes. In any kind of a process or an operation, we normally expect some variation in the result of an operation as a rule rather than an exception. In general, variation in a system is classified into two categories. Chance variation(or random variation) is due to the interaction of a combination of many random variables (called chance causes) that result slight difference in outcome in a random manner. There is very little we can do about these chance variations. On the other hand, assignable causes should be removed by taking corrective actions as soon as they are identified.

Then, the recognition of expected variation by chance causes in the determination of standards is essential if control is to be instituted effectively in an operation. The limits for the chance variations are called the natural tolerance limit, i.e., the range of allowable deviations, within which no corrective action should be taken. Only when we have knowledge of the natural tolerance, a decision can be made as to whether the observed variation is acceptable or consitute an exception to acceptable performance, and consequently, the principle of "management by exception" can be utilized effectively and efficiently in a control system. This means that we should use range estimates of standards which represent the natural tolerance limits in the variation of performance. On the other hand, if the absolute, inflexible standard of performance is demanded, we may tend to get it even if this means the preparation and distribution of "phony" performance figures.

It is well known that the concept of statistical control can serve as a useful tool for setting the natural tolerance limits.(5)

II. Cost Behavior Analysis

1. Cost Functions

A fundamental step in control is to determine to some degree what should be the results, or what are the expected levels of performance. For cost control of decentralized operations, the standards for operating coats are derived by analyzing actual cost incurred over a period of time. In the first place, the analysis of past cost behavior results a cost function which represents the variability of cost with output and other decision variables for the operations. Once the cost function of the operations is estimated, the function can be used as a prediction model for the purpose of setting cost standards. As a prediction model, the cost function of the operations tells the management the amount of operating cost that will occur for each activity or output level of the operation. Furthermore, the operating costs predicted by the cost function is the "attainable" cost standards because the function is derived on the basis of past cost performance.(6)

In studying the cost function, the functional relationship is defined as;

$$C=f(X_1, X_2, \cdots\cdots\cdots\cdots X_K, u)$$

(5) Most of statistics texts for business decisions deals with the statistical control technique.

(6) Economists have studied cost functions to determine the relationship between costs and output. Their main concern was to test economic hypotheses about the nature of the productive process, from which they built a conventional theory of price and resource allocation. A representative work in this area is Johnston's extensive statistical estimations of cost functions in several incustries. See J. Johnstone, Statistical Cost Analysis, McGraw-Hill Book Co., Inc.,

Where C; costs

X_i; rate of output and other factors which influence cost. The functional relationship shows costs as a dependent variable and output and other decision variables as independent variables.

Most of economists' work on cost function was done at the industry level. On the other hand, the cost control model for an operation requires the estimation of a cost function at the firm level.

In designing cost control system, the knowledge of a cost function is extremely important as the whole system is based on the cost function. The cost function for cost planning and control purpose should be determined scientifically and should be so estimated as to yield the attianable standards. An application of the statistical control techniques to the estimated cost function will allow specification of the natural tolerance limits for chance variations and yield the range estimates of standards.

2. Delimitation of the Study

A cost function can be estimated at an industrial level as economists did, or at the firm level for a specific operation. Also a cost function can be estimated for total cost, total variable cost, or each category of cost in a firm. Thus, it is necessary to delimit the scope of our study here before we go into the review of existing techniques of cost estimation and the development of new models.

This research is confined to estimation of a cost function for the operation performed by several units in an organization, and to the establishment of a uniform cost control system that is applicable to the operationally homogeneous units.(7)

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(7) Here the operationally homogenous units are referred to those units which;

a) are assigned the same tasks to perform

b) have the same operating technology, and

c) are given the same authority and responsibility for an efficient performance of the assigned operation.

Specifically, the research will deal with cost control problems in the following business conditions;

(a) An organization consists of several operating units, where all the units perform similar tasks or activities.

(b) All the operating units use the same or similar production techniques to the extent that they have the same machinery, equipment, and standard operating procedures.

(c) Each unit may be regarded as a cost center where costs are accumulated, controlled, and planned with the authority and the responsibility for efficient performance.

(d) The extensive decentralization of homogenous operations to the units requires well established cost planning and control system for efficient performance and overall profits of the organization.

With the decentralized operations of this nature, the cost control problem becomes a unique one, as discussed earlier, that

(a) we estimate only one cost function for the operations performed by the operationally homogenous units

(b) a uniform cost control system applicable to all the units can be developed on the basis of the estimated cost function.

The uniform cost control system for the operationally homogenous decentralized units will have two fold functions;

(a) for the manager of a decentralized unit, it helps set standards, discover and report the deviations from the standards, and enable him to take corrective action so as to achieve the desired results, and

(b) for the top management of the operation, the system will provide information and a meaningful measure of relative performance in terms of cost among the decentralized units, because the cost control system is based on the cost function of the operation at all the units and is applicable to all the units. Hence the cost control system will be an effective tool for the evaluation of performance in each decentralized unit on an equal basis and consequently direct the operation or a unit toward more efficient performance by proper guidances.

In the real world, it will be hard to find an organization whose decentralized units are identical in terms of production techniques and the operation assigned. But if the decentralized units are reasonably similar in the nature of operation and use same equipments and machinery, and/or standard operation procedures in production activity, we may say that the units perform operationally homogenous activities. Whenever an organization consists of a large number of operationally homogenous units, the cost behavior models developed in this study will be applicable for an establishment of cost control system. Examples of such organization are a chain of supermarkets, food service chains, branch banking operations, and etc.

Finally, the cost contol models developed in the study assume that the decentralized units face identical input prices. This assumption can be easily removed by including the price variables in the model if the input price are different for the units.

3. Review of Prior Research

In the past, it has been suggested that multiple regression analysis can be used to estimate the cost function in the decentralized operations. Specifically Comisky[8] applied multiple regression analysis to cost control of decentralized operations in the consumer finance industry. Benston[9] estimated cost function of banks as well as savings and loan industry operations, and Jensen[10] discussed a more general multiple regression model together with its complication in a relastic cost control situation.

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(8) Comisky, Eugene E., "Cost Control by Regression Analysis," *The Accounting Review*, April, 1966, pp. 235-238.

(9) Benston, G., "A Multiple Regression Analysis of Cost Behavior," *The Accouning Review*, Oct. 1966.

(10) Jensen, Robert E., "A Multiple Regression Model for Cost Control Assumptions and Limitation," *The Accounting Review*, April 1967, pp. 265-273.

In their work, the cost function of an operation performed at m decentralized units is estimated by the use of multiple regression analysis. The multiple regression cost model with m decentralized units over one accounting period (eg. fiscal year) where the reported total (eq. monthly) direct cost C_j for unit j is:

$$Eq.\ (1)\ C_j = b_0 + \sum_{i=1}^{n} b_i X_{ij} + U_j$$

for $i=1\ldots n$ activities

$j=1\ldots m$ units

where X_i is the level of output or other activites that influence the direct cost of the operation, b_0 is the constant, b_i is a regression coefficient, and U_j is the disturbance term.

When the regression model was fitted by the method of least squares, it has the following characteristics.

(a) The least squares method results the sum of the squared deviations between the regression line and the actual point smaller than they would be from any other straight line.

(b) The deviations above the regression line equal those below the line, on the average.

(c) The straight regression line goes through the overall mean of the data.

(d) Consequently, the regression line is called the line of average relationship, indicating that it is a plot of the average value of the dependent values for different values of independent values.

(e) The coefficient estimates by the least squares are best linear unbiased estimates (BLUE). As a result, when the regression analysis model is used for cost estimation purposes for the decentralized operations, the regression cost behavior model represents the average relationship between costs and factors that influence the costs among the operating units.

The statistical assumptions underlying the application of linear regression analysis are discussed in detail later. In summary, those are:

1. The disturbance terms are normally distributed.
2. The disurbance terms have constant variance.
3. The disturbances are independent of each other.
4. The independent variables are not correlated each other.
5. The relationship between the costs and the output and other contributive factors are linear.
6. The error term is not correlated with any of the independent variable.

It has been cautioned that the result of regression analysis is subject to the degree to which the statistical assumptions are met.(11)

The usefulness and importance of the linear regression analysis as a quantitative analytical tool is reflected in the frequency of its usage in econometrics. The econometricians have employed the regression model as a major tool of research in the estimation of production cost, and other economic functions. In accounting, regression analysis has been a valuable tool for measuring costs in the recurring decision problems and in the decentralized operations. Specifically, the regression model has been used for

(a) the establishment of a cost control system
(b) the preparation of flexible budget, and
(c) the analysis of cost structure for recurring decision problems and the decentralized operations.

For the cost control of decentralized operations, the regression model has been the most important mathematical tool in estimating the cost function. In this study, the primary objective is to develop a model that goes beyond the regression analysis model in measuring operating costs for decentralized units.

(11) see Jensen, *op. cit.*

4. Normal vs. Ideal Standards

When the multiple regression analysis is applied to the decentralized operations with one period data, the regression equation is

Equation (1) $C_j = b_0 + \Sigma b_i X_{ij} + u_j$ for $i = 1 \ldots\ldots n$ activities
$j = 1 \ldots\ldots m$ units

where C = total direct cost
X_{ij} = level of activities i at j unit

Since the estimates of the regression coefficients, b's, reflect the average relationship between the costs and the level of outputs and activities among the operating units over the period, the model produces "attainable normal" estimates of the operating costs. The attainable normal is defined as the average performance under normal operating condtions by the decentralized units. Thus, these estimates are not by any means measures of most efficient performance. But the multiple regression model reflects the average performance of the decentralized units and thus results the "attainable normal" standards.

On the other hand, if we can estimate the "attainable ideal which reflects the most efficient performance amount the operating units, the standards will help management set his goal for performance of the units. Furthermore, the management can do the traditional cost variance analysis by comparing the actual cost incurred, the attainable "normal" cost standard, and the attainable "ideal" cost standard.

In order to distinguish the cost function which reflects the average performance from the cost function which represents the most efficient performance, the former is called an average cost function, and the latter a frontier cost function.

Once the frontier cost function is estimated, we can analyze the difference among the followings:

(1) the cost estimate from the frontier cost function

(2) the cost estimate from the average cost function

(3) the actual cost incurred

The difference between the cost estimate from the frontier cost function and the cost estimate from the average cost function, (2)—(1), will show the top management of the organization possible improvement potential for the operation of the units on the average. The comparison of the actual cost incurred with cost estimate from the actual cost incurred with cost estimate from the average cost function, (3)—(2), will show the management of the unit the degree of deviation in cost performance from the average operation. Also the comparison of the actual cost incurred with the cost estimate from the forntier cost function, (3)—(1), will provide the management of the unit with the knowledge of possible improvement potential for the unit, if any, or how well the unit is doing on the average.

The above analysis explore some improvement potentials for each unit and provide us a further insights for cost control and evaluation of cost performance. This is done by estimating the attainable normal and ideal cost standards. Moreover, if the organization's top management set an operational standard as the lowest direct cost, the frontier cost function will yield the standard.

It is stated in the above that the multiple regression analysis applied to the past cost data of decentralized operations can be used to estimate the average cost function or to estimate the attainable normal cost standards. But there has been no models developed to derive the frontier cost function for the decentralized units. Hence, there is a definits need to develop a model that will derive the frontier cost function for the decentralized operations.

III. The Model

1. The Frontier Cost Function Model

In applying the multiple regression model (equation 1) to the decentralized operations facing indentical input prices, the estimates of the coefficients, b_i, are averages among the operating units and the application of the cost function obtained by the regression model produces estimates of total direct costs under normal conditions of operation.

Thus, those estimates of total direct cost should not be interpreted as a direct measure of good or acceptable performance and they are not equivalent to carefully constructed standard costs because they are estimates based on the assumption of average operations. The usefulness of these estimates stems from a comparison of the estimated total direct costs with the observed (actual) cost at the given level of output and activities in a unit, which will highlight cost levels that deviate from average relationship.

The multiple regression model of cost behavior for the decentralized operations uses the cross-sectional data, i.e., the past data on operations of each unit over an accounting period. With m decentralized operations, the model consist of the following m equations that represent the cost structure of each units operation;

$$b_0+b_1X_{11}+\cdots\cdots+b_iX_{i1}+\cdots\cdots+b_nX_{n1}=C_1 \text{ for unit } 1$$
$$b_0+b_1X_{12}+\cdots\cdots+b_iX_{i2}+\cdots\cdots+b_nX_{n2}=C_2 \text{ for unit } 2$$
$$b_0+b_1X_{1m}+\cdots\cdots+b_iX_{im}+\cdots\cdots+b_nX_{nm}=C_m \text{ for unit } m$$

where C_j; the total direct cost

X_{ij}; level of ith activities at jth unit

b_i; regression coefficients

U_i; disturbance terms

In a simpler form, they are same us the equation (1).

$$\text{Eq. (1)} \quad b_0+b_iX_{ij}+U_j=C_j$$

Here, C_j and X_{ij} are provided by the cross-sectional data. The regression coefficients, b_i, are unknown but the use of the least squares method yields the estimates of b_i, which reflects the average relationship between C_j and X_{ij} among the decentralized units.

Using the same set of data and variable in the above m equations that represent the cost structure of each units operation, we may find the frontier cost function. Earlier we defined the frontier cost function as the cost structure that represents the best performed operation among the m decentr-alized operations facing indentical input prices. For a given level of output and decision variables, the best performed operation incurr the least total direct cost.

Then, our problem is to obtain an estimated function

$$\text{Eq. (2)}\quad \hat{b}_0+\Sigma\hat{b}_i X_{ij}=C_j$$

Where b's are set in such a way that

$$\text{Eq. (3)}\quad \hat{b}_0+\Sigma\hat{b}_i X_{ij}\leq C_j$$

where c_j is an estimate of C_j which is the actual total direct cost at j th unit.

From the above, it is apparent that equation (3) is the constraints which must be satisfied in the derivation of the b's in the frontier cost function.

On the other hand, we may redefine the best performed operation as the one that achieves the higher level of activities within the given constraints of equation (3). But, since the data are based on m decentralized operating units,the objective function is formulated as equation (4);

$$\text{Eq. (4) Maximize}\quad \hat{b}_0+\Sigma\hat{b}_i\bar{X}_i$$

where $\hat{b}_i$ is the coefficient estimate for ith activity, and $\bar{X}_i$ is the mean of X_i.

In summary, we want to obtain an estimated function

$$\text{Eq. (2)}\quad \hat{b}_0+\Sigma\hat{b}_i X_{ij}=\hat{C}_j$$

were b's are set in such a way that

$$\text{Eq. (3)}\quad \hat{b}_0+\Sigma\hat{b}_i X_{ij}\leq C$$

where $\hat{C}_j$: estimated total direct cost at jth unit.

C_j: actual total direct cost at jth unit

$\hat{b}_i$: estimates of coefficient b_i

Then Eq. (3) becomes the constraints that should be satisfied in estimating b_i.

Also, by redefining the frontier cost function as the one that achieves higher level of activities within the given constraints of Eq. (3), the objective function is formulated as

$$\text{Eq. (4) Max: } \hat{b}_0 + \Sigma \hat{b}_i \bar{X}_i$$

where we have used $\bar{X}_i$, mean of the X_i's because the data are based on m decentralized units.

The problem is, then, a linear program whose objective is to maximize equation (4) subject to equation (3):

$$\begin{aligned} \text{maximize } & b_o\bar{X}_i + b_1\bar{X}_1 + \cdots\cdots b_n \bar{X}_n \\ \text{subject to } & \hat{b}_o X_o + \hat{b}_1 X_{11} + \cdots\cdots \hat{b}_n X_{n1} \leq C_1 \\ & \hat{b}_o X_o + \hat{b}_1 X_{1m} + \cdots\cdots \hat{b}_n X_{nm} \ C_m \\ & \hat{b}_o, \hat{b}_i \leq 0, \\ & i = 1 \cdots\cdots n \text{ and } j = 1 \cdots\cdots m \end{aligned}$$

where $\hat{b}_o$ is the constant, $\hat{b}_j$ is the estimate of coefficient of ith variable, X_{ij} is the observed level of output or decision variable i in the jth unit, $X_o = 1$ in order to obtain a constant term, and C_j is the actual operating cost in the jth unit. By solving the above linear programming, we obtain the estimates of b_o and b_i for the frontier cost function.

IV. Conclusion

In the study, we have two linear models of cost analysis;

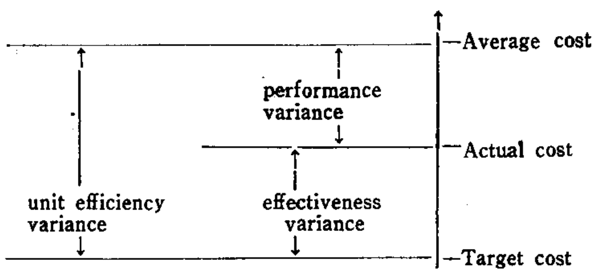
Model (1); Multiple Regression Model

Model (2); Linear Programming Model.

The study is attempted to expand the models for the analysis of cost behavior from the multiple regression model to the linear programming model.

The linear prgramming model is formulated to estimate the frontier cost function which reflects the best possible operation in the system. While the multiple regression model yields the "average" cost function during a time period throughout the decentralized units, the frintuer cost function can be used to yield the "attainable ideal" cost or "target cost" which is still accomplishable under the given set of conditions in the system.

The ⟨figure I⟩ represents a useful was to describe the variance analysis of the total direct costs;



⟨**Figure I**⟩

Assuming that we have an ordering of the costs for a given level of activities in the above schmatic diagram;

(a) the unit efficiency variance is the difference between the target cost and the average (expected) cost. This variance provide a measure of over all improvement potential for a long-run basis.

(b) the performance variance is the difference between the average cost and the actual cost. This variance represents the degree of variation in the total direct cost from the average (expected) level.

(c) the effectiveness variance is the difference between the target cost and the actual. This variance provides a measure of how effectively the operation was performed in comparison with the best performed operation.

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