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ABSTRACT

This paper advances a model, called the expected opportunity loss model, for curriculum evaluation. This decision-making technique utilizes subjective data by ranking courses according to their expected contributions to the primary objective of the total program. The model also utilizes objective data in the form of component costs, and differs from traditional cost-effectiveness models in that it places less emphasis on the cost components. The purposes of the decision model are (1) to formulate alternatives for decision making under uncertainty, and (2) to appraise the probable or conditional opportunity loss. The minimum loss is the optimum decision. (DE)

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PROGRAM EVALUATION IN COST BENEFIT TERMS

Advanced in this paper is an evaluation model applicable to school curriculum evaluation. The developing concept is based on some concepts of expected and conditional value. Proposed herein is a method for determining value judgments of a well-defined educational program. This section precedes the expected opportunity loss (EOL) model-a term to be defined later. As a technique for decision making, I propose that the EOL model is more appropriate for educational program evaluation than the traditional cost/effectiveness model because less emphasis is placed on cost in the EOL model.

Data utilized in the EOL decision model are of two types: (1) subjective data assigned by ranking elements (courses) according to the primary objective of the total program and (2) program component costs, the objective data base. First, the subjective data base will be discussed.

SUBJECTIVE MEASUREMENT

There is relatively little question that an ordinal scale for measuring subjective judgments is possible. However, this model is primarily dependent on the <u>interval scale</u>; and the properties of isomorphism, equality, inequality, and additivity are necessary to formulate expressed rankings or preferences. Utility and subjective value judgment are synonymous in this presentation, where utility has been removed from the classical view involving money. Proposed here is the idea that "utility is a function that arithmetizes the relation of preference under conditions of risk or uncertainty" (1:47).

One primary assumption in measurement of the utility of a given set of courses is that all materials or program elements are potentially quantifiable. Utility measurement of curriculum is, indeed, an obscure area in the field of education. However, the approach advanced in this paper is concerned with the elusive problem of assigning value judgments by rank to educational program elements for the purpose of determining order of value/or utility. Program component utility is also defined as the relation of preference under uncertainty for the program objective achieved per course. The assumption that each program element contributes to the value of the total program is of major importance in this decision model.

Ideally, only those individuals experiencing all elements of the total program should assign ranks in the evaluation. Furthermore, a sample of approximately 30 is recommended to minimize error. In general, the possibility exists in a large sample that all elements of a total program may be equal in rank. If this is the case then the costs, usually unequal, become the major contributing elements of choice.

When participants have ranked all program elements, the probabilities of value per program element are determined by transmutation of rank orders into units of worth (2:309-336). To calculate the relative percent of worth (RPW) per program component, the formula $(RPW) = (r. - .5)\frac{100}{n}$ is used, where r is the assigned rank and n is the total number of program elements ranked. The mean relative percent of worth per element is transformed into a mean unit of worth (W) per program component. All units of worth, one per program component, are subsequently normalized for utilization as probabilities of utility in the EOL decision model.

Subjective values transformed into probabilities of worth form the basic foundation for utility measurement in the EOL decision model. An assumption supporting scaling judgments or assigning subjective ranks to program components is that the participant's assigned ranks follow the normal probability distribution. The goodness-of-fit test is appropriate to determine whether the assigned values approximate the normal probability distribution. If the subjective values do not approach the normal probability distribution, then two alternatives are suggested: (1) A larger sample must be obrained, or (2) collapsing cells with less than a given number of observed frequencies is a solution.

Subjective judgments affect the degree of utility, as estimated per individual, that results from experiencing each program element. Furthermore, subjective values affect the original selection of the total program objective and courses to be offered. Therefore, the values of both the program planners and persons experiencing the program are incorporated in the evaluating process.

EXPECTED OPPORTUNITY LOSS

Introduction

The purpose of the decision model is to formulate alternatives for decision under uncertainty and appraise opportunity loss (3:38-54). In general educational terminology, opportunity loss is the aggregate worth given up by failing to include the set of courses or program components that will produce the greatest benefit based on utility and program costs.

By utilizing subjective and objective data in the evaluation process, the educational planner has two primary concerns: (1) To establish what the programs have provided for students through the present time and, (2) to predict future program effectiveness under analogous conditions. Hence, the element of risk is involved in evaluation and planning. Risk is primarily dependent on the planners responsible for formulating objectives, and individuals that estimate values by ranking the elements. The following definitions, assumptions, and principles are presented as steps in determining alternatives for choice in the EOL decision model.

Historical Value Judgments

In the evaluation of the total program it is imperative to know something about past value judgments, following the assumption that they .y serve as a guide to what may be expected in future programs. Thus, the mean unit of worth (W) per program component becomes the historical data that is transformed into value probabilities, the sum of which is one. A value probability is defined as that probability which represents the degree of usefulness or utility of a program component. That is, it represents the extent of the total program objective reached by a given program component. In the EOL model it is impossible for a program element to contribute nothing. There will be a probability of worth per element that is greater than zero and less than one because each element is assumed to contribute some degree of utility to the program.

To determine the historical value judgments that are based on assigned ranks, all mean units of worth (W_i) are normalized. For example, assume (P_n) program elements and (W_n) mean units of worth. The objective is to derive the probabilities of value or utility (U_i), where the sum of all U_i (i = 1,2,3, ... n) is one. In Table I the value probability per program element is determined as follows:

$$U = \frac{W_i}{\sum_{i=1}^{n} W_i}, \quad (i = 1,2,3, \ldots n).$$

Program Cost Analysis

The purpose of the program cost analysis is to specify the selling price of the total program. Included in the process of identifying the costs of the resources allocated per program element are expenditures for administration, instructional salaries and materials, overhead, capital outlay, debt service, maintenance, auxiliary services, debt service, fixed charges, maintenance and transportation.

Public education, in theory, is a "break-even" business; therefore, for the most elementary budgetary form the selling price and program cost must be equal. The EOL model utilizes the "break-even" concept. Costs

TABLE I

HISTORICAL VALUE JUDGMENTS

Program Elements	Mean Units of Worth	Value Probabilities (Utility)
P_1	W_1	U_1
P_2	W_2	U_2
$\vdots$	$\vdots$	$\vdots$
P_n	W_n	U_n
		$\sum_{i=1}^{n} U_i = 1$

of program components per hour of credit earned per student are standardized to present the selling price in amenable form for comparison.

Conditional Worth

For this decision model, the conditional worth is the difference between the cost of one credit hour per program component and the selling prices of all elements. Conditional worth (in dollars) is dependent on interaction between the program costs and selling prices. The general procedure used for calculation of the conditional worth for one credit hour of program element (P_i) is shown in Table II. The difference between the selling prices (S_i) of all elements and cost of the given element (C_i), ($i = 1,2, .. n$) are illustrated in column four. By definition the absolute value of $S_i - C_i$ is zero.

According to the "break-even" concept, the diagonal of the matrix of conditional worth for a total program will have an optimal decision, applicable to conditional opportunity loss, of zero. This matrix, Table III, is determined by procedures introduced in Table II. The optimal profit decision is: $S_1 - C_1, S_2 - C_2, \ldots, S_{n-1} - C_{n-1}, S_n - C_n$.

Conditional Opportunity Loss

Conditional opportunity loss is the difference between the optimal profit decision and the conditional worth of the alternative course propositions. The optimal profit decision on this model is zero, and conditional worth (Tables III and IV) are identical. In the EOL model, the conditional opportunity losses are expressed by absolute differences and, by definition, cannot be negative.

TABLE II

CONDITIONAL WORTH OF ONE CREDIT

HOUR OF (P_i) - $(i = 1,2, \ldots n)$

Program Elements	Selling Price of Each Element	Cost of (P_i)	Conditional Worth of (P_i)
P_1	S_1	C_i	$S_1 - C_i$
P_2	S_2	C_i	$S_2 - C_i$
⋮	⋮	⋮	⋮
P_n	S_n	C_i	$S_n - C_i$

TABLE III

CONDITIONAL WORTH

Program Elements	Conditional Worth of All Program Components			
	(P_1)	(P_2)	$(\ldots)$	(P_n)
(P_1)	$S_1 - C_1$	$S_1 - C_2$	...	$S_1 - C_n$
(P_2)	$S_2 - C_1$	$S_2 - C_2$	...	$S_2 - C_n$
⋮	⋮	⋮		⋮
(P_n)	$S_n - C_1$	$S_n - C_2$	...	$S_n - C_n$

TABLE IV

EXPECTED OPPORTUNITY

LOSS FOR (P_1)

Program Elements	Value Probabilities	Conditional Opportunity Loss	Expected Opportunity Loss
P_1	U_1	$S_1 - C_1$	$U_1 (S_1 - C_1)$
P_2	U_2	$S_2 - C_1$	$U_2 (S_2 - C_1)$
⋮	⋮	⋮	⋮
P_n	U_n	$S_n - C_1$	$U_n (S_n - C_1)$
			$\sum_{i=1}^{n} U_i (S_i - C_1)$

Expected Opportunity Loss

The EOL for a program element (P_i) is the sum of the products of each value probability and the conditional opportunity loss. Procedures for determining EOL for (P_1) are illustrated in Table IV. If all costs (C_i) and selling price (S_i) are equal then the conditional worth and the conditional opportunity loss is zero. If this is the case in Table IV, the EOL is, indeed, zero. Therefore, the solution in terms of cost is trivial, and the only remaining elements of choice are the value probabilities. The minimum EOL per set of alternatives is the optimal decision. Table V illustrates the expected loss for a program with (P_n) elements. The expected loss is amenable to predicting the success of a future program, assuming like conditions, in terms of utility and cost, and is a proposed procedure for evaluating a continuing or completed program.

SUMMARY AND CONCLUSIONS

The EOL decision model may best be summarized by the flow chart in Figure I. Input for the model is basically comprised of program utility (U_i), program costs (C_i), and program selling price (S_i). The technique of ranking is utilized to determine utility from a sample of students that have experienced the total program. A "break-even" proposition is assumed in the educational institution to determine conditional worth (Table III). Therefore, the optimal profit decision is, indeed, zero. Those concepts illustrated in Table II, III, and IV represent the process whereby the desired output is achieved. The output is the set of alternatives, expected losses, illustrated in Table V. The minimum loss is the optimal decision.

TABLE V

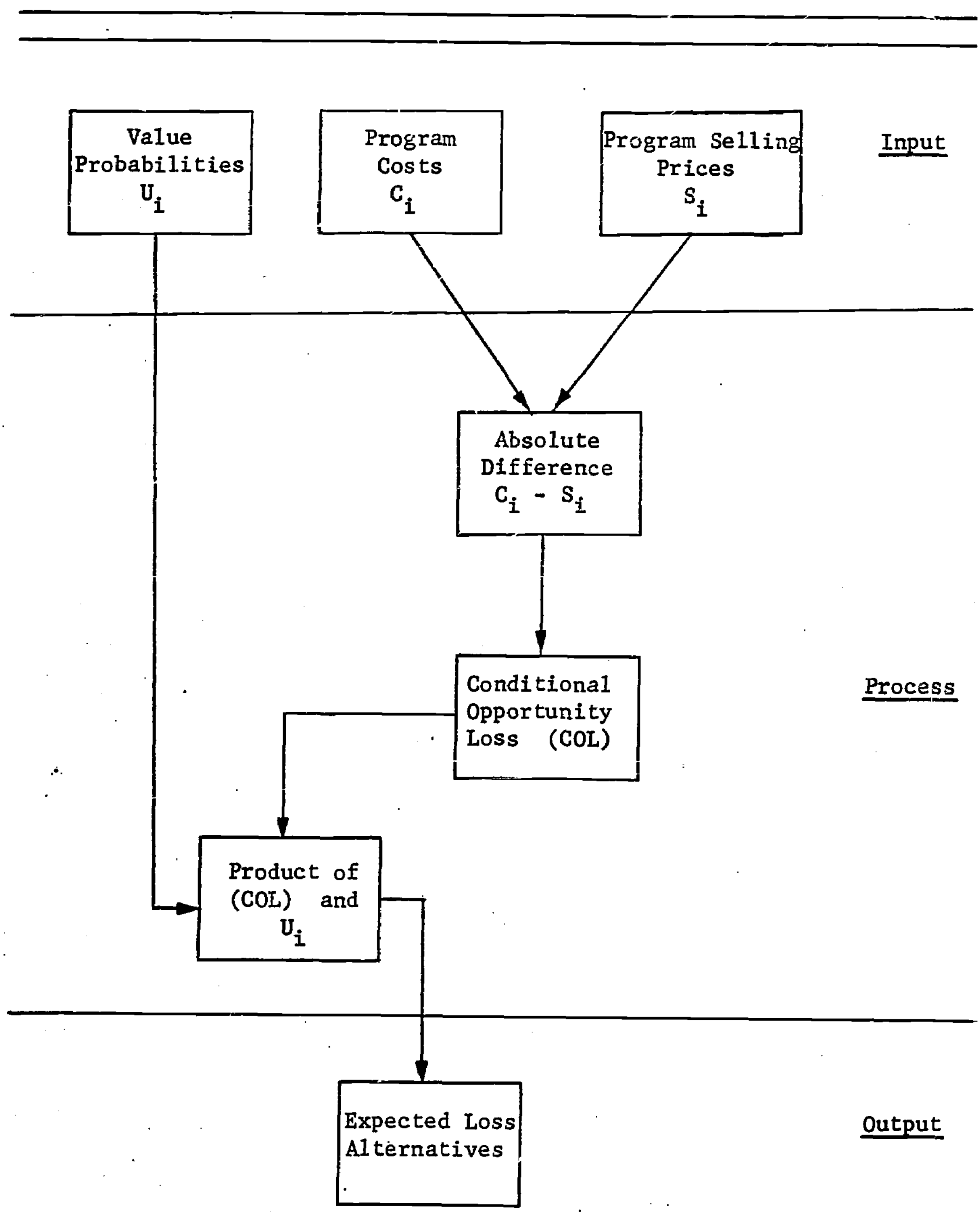
EXPECTED LOSS

Program Elements	Expected Loss
P_1	$\sum_{i=1}^{n} U_i (S_i - C_1)$
P_2	$\sum_{i=1}^{n} U_i (S_i - C_2)$
⋮	⋮
P_n	$\sum_{i=1}^{n} U_i (S_i - C_n)$

FIGURE I

INFORMATION FLOW FOR THE

EOL DECISION MODEL



What are the advantages of EOL over traditional cost/effectiveness procedures? One important advantage is the interaction between program costs as displayed in Table II. Not only is there interaction between program costs in the EOL model, but there is dependence upon all assigned value probabilities for each EOL per program (Table IV). There is, in fact, double dependence, value and cost, in each program EOL. On the other hand, in traditional cost/effectiveness models only a one to one correspondence determines the decision ratio.

This discussion was not intended to imply that a "one-shot" evaluation of an educational program is by any means adequate. The two major purposes were, in fact, to suggest a working decision model and encourage further research and systematic evaluation. When systematic evaluation is continued, it is possible to compare the accumulating data and by frequent monitoring of the program establish a broad data base for improvement of decision-making. This data base involves the EOL criterion, selected performance indicators, and subjective judgment of the decision maker. All aspects of evaluation should greatly depend on behavioral objectives.

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