Management Services: A Magazine of Planning, Systems, and Controls

Volume 6 | Number 3 | Article 8

5-1969

Scientific Techniques for Improving School Management Effectiveness

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As education costs soar, it becomes even more essential to hold down the costs of supporting functions. This author suggests a way of measuring their efficiency —

SCIENTIFIC TECHNIQUES FOR IMPROVING SCHOOL MANAGEMENT EFFECTIVENESS

by Harold I. Steinberg

Peat, Marwick, Mitchell & Co.

ONE of the few irrefutable statements about education is that its costs are going up, up, and up. While this axiom is particularly true of classroom activities, it applies to the supporting or noninstructional activities as well.

It is essential to get the most for the supporting function dollar—first, in order to have more money available for the educational program and, secondly, in order to lessen the chances of a taxpayer's revolt. Fortunately, the availability of scientific management techniques now gives the school administrator a way to determine whether he is furnishing this support effectively and economically.

The New York State Education Department, through the division of educational management services, recognizes the value of these new techniques. It has recently used operations research (the application of mathematics to solve business problems) to develop a measure of the effectiveness of one of the more expensive supporting activities—pupil transportation.

A two-page questionnaire was mailed to approximately 500 school districts in New York State. This questionnaire asked for data pertaining to such factors as the area of the district, the number of miles of paved and unpaved roads, the topography of the district, the number of students transported, the scheduled starting time of various grades, the number of vehicles by capacity, and so on.

When the questionnaires were returned, the data were transcribed onto punch cards and entered into a high-speed computer. Using the technique* of multiple linear regression, five mathematical formulas were developed for evaluating the management effectiveness of pupil transportation activities. A sixth formula was also produced for evaluating cost control and/or indicating the budgetary impact of a change in transportation policies. These formulas are shown in Exhibit 1 on page 53.

Measure of efficiency

The purpose of the formulas is to enable districts to compare themselves to other districts in spite of differences that would ordinarily defy comparison. Looking at this another way, if all school districts were exactly alike in the number of students transported, area of the district, miles of road, etc. and were operated with equal efficiency, the chances are that the number of buses and seats provided, the number of miles and hours the buses were run, and the cost of furnishing transportation would be fairly similar for all districts. In other words, one district's costs differ from another's because of environmental elements that a district superintendent *cannot* control, but costs also are affected by

*The multiple linear regression technique was applied with the aid of a computer program entitled BMDO2R. This program was developed at the Health Sciences Computing Facility, Department of Preventive Medicine and Public Health, School of Medicine, University of California at Los Angeles. It is usable on IBM 7090/94 equipment. Application of this program to the raw data results in the production of coefficients for each of the factors that were preidentified as probably relevant to transportation activities. These coefficients form the basis of the formulas.

The technique can be achieved by a person possessing a mathematical background who is willing to apply himself to the solution of this problem. A good text for explaining the solution is *Introduction to Multi-Variate Statistical Analysis* by T. W. Henderson, John Wiley and Sons, New York, 1966.

the degree of efficiency with which the transportation activities are managed. This he *can* control. By means of the new scientific techniques, factors can be developed and applied to negate the effects of the environmental elements so that each district can then compare the efficiency of its operations to that of other districts or to the statewide average.

It is intended that a superintendent will use all the formulas together in order to evaluate the overall effectiveness of the transportation operation. An example of how he would use them and analyze the results has been randomly selected and is presented here.

Example

Applications . . . need not be limited to transportation . . . The same technique could be applied to such problems as the number of clerical personnel, the school lunch program, custodial services and supplies, and the school attendance function.

Assume that a district has accumulated the following data:

Number of students transported	2,819
Number of assigned buses	35
Number of assigned seats	1,861
Miles per year	378,000
Hours per year	25,200
Flat terrain	10%
Moderately hilly terrain	80%
Very hilly terrain	10%
Area of school district	76
Paved roads	200
Unpaved roads	10
Actual costs	$199,688

The superintendent would substitute the values into the formulas and calculate the results. The figures provided by the formulas and the actual results would then be compared as shown in Exhibit 2 on the opposite page.

In this situation, most of the formula estimates are very close to the actual data. However, both cost formulas show approximately the same amount of overexpenditure. It cannot be attributed to too many buses or seats or too many miles or hours driven. Therefore a cost control problem probably exists. The superintendent would be well advised to examine the wage structure and possibly other personnel factors that contribute to cost.

Other applications of the formula have revealed the ownership of more buses than necessary and excessively high prices proposed by contract bus operators.

Naturally, the formulas illustrated here apply to only New York State's pupil transportation activities. Also, field testing has revealed that slightly different formulas are appropriate for those districts in which the number of pupils per square mile requiring transportation is unusually high. Formulas can be developed with equal ease for other states, however. The present formulas lose reliability as time passes, of course, but they can be updated simply by gathering and analyzing the latest data available.

Applications of the multiple linear regression technique and mathamatical formulas for evaluating management effectiveness need not be limited to transportation. The study that produced these formulas also indicated that the same technique could be applied to such problems as the number of clerical and secretarial personnel, the school lunch program, custodial services and supplies, and the attendance function.

In short, the recent and rapid evolution of scientific management provides the school administrator with a powerful new tool for increasing his management effectiveness.

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EXHIBIT 1

Formulas

1. Total Transportation Cost

$$\text{Total Transportation Cost} = \text{Number of Students Transported} \times \left[61.49 + 21.28 \times \frac{\text{Miles of Unpaved Roads}}{(\text{Miles of Paved} + \text{Unpaved Roads})} - .068 \times \frac{\text{Number of Students Transported}}{\text{Area of school District}} + .053 \times \text{Terrain Factor} - .003 \times (\text{Miles of Paved} + \text{Unpaved Roads}) \right]$$

2. Number of Buses

$$\text{Number of Buses} = \text{Number of Students Transported} \times \left[.011 + .0077 \times \frac{\text{Miles of Unpaved Roads}}{(\text{Miles of Paved} + \text{Unpaved Roads}} - .00002 \times \frac{\text{Number of Students Transported}}{\text{Area of School District}} + .00002 \times \text{Terrain Factor} \right]$$

3. Number of Seats

$$\text{Number of Seats} = \text{Number of Students Transported} \times \left[.609 + .235 \times \frac{\text{Miles of Unpaved Roads}}{\text{Miles of Paved} + \text{Unpaved Roads})} - .0008 \times \frac{\text{Number of Students Transported}}{\text{Area of School District}} + .001 \times \text{Terrain Factor} - .00004 \times \text{Miles of Paved} + \text{Unpaved Roads} \right]$$

4. Total Miles per Year

$$\text{Total Miles per Year} = \text{Number of Students Transported} \times \left[152.01 - 17.35 \times \frac{\text{Miles of Unpaved Roads}}{(\text{Miles of Paved} + \text{Unpaved Roads})} - .229 \times \frac{\text{Number of Students Transported}}{\text{Area of School District}} + .164 \times \text{Terrain Factor} + .029 \times \text{Miles of Paved} + \text{Unpaved Roads} \right]$$

5. Total Hours per Year

$$\text{Total Hours per Year} = \text{Number of Students Transported} \times \left[9.835 - 6.89 \times \frac{\text{Miles of Unpaved Roads}}{\text{Miles of Paved} + \text{Unpaved Roads}} - .014 \times \frac{\text{Number of Students Transported}}{\text{Area of School District}} + .0348 \times \text{Terrain Factor} - .0002 \times (\text{Miles of Paved} + \text{Unpaved Roads}) \right]$$

6. Total Transportation Cost (Budgetary Impact)

$$\text{Total Transportation Cost (Budgetary Impact)} = \text{Number of Assigned Buses} \times \left[-623.00 + 103.20 \times \text{Average Number of Seats per Assigned Bus} + .038 \times \text{Average Yearly Miles per Assigned Bus} \right]$$

EXHIBIT 2

Efficiency Evaluation

	By formula	Actual	Difference
Cost — for measuring effectiveness	$182,276	199,688	+17,412
Buses (assigned)	36	35	—1
Seats (assigned)	1,922	1,861	—61
Miles	465,641	378,000	—87,641
Hours	35,027	25,200	—9,827
Cost — for determining budgetary impact	184,380	199,688	+15,308