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ED 014 153

EA 000 876

DETERMINATION OF THE LOCATION FOR AN AREA SCHOOL.

BY- DOST, JEANNE

PUB DATE JAN 67

EDRS PRICE MF-$0.25 HC-$0.40 8P.

DESCRIPTORS- *SCHOOL LOCATION, URBAN AREAS, RURAL AREAS, *MODELS, *STUDENT TRANSPORTATION, GEOGRAPHIC DISTRIBUTION, ECONOMIC FACTORS, *BUS TRANSPORTATION, POST SECONDARY EDUCATION, COMMUTING STUDENTS, *EDUCATIONAL PLANNING, LAS VEGAS,

TWO MODELS ARE PRESENTED TO AID PLANNERS IN SELECTING THE SITE FOR AN AREA SCHOOL WHICH IS MOST EFFICIENT IN MINIMIZING TIME AND COSTS OF TRANSPORTING STUDENTS. THE FIRST MODEL DEALS WITH THE RELATIONSHIP OF SCHOOL SITE AND BUS TRANSPORT PROBLEMS. SOLUTION TO THE SITE PROBLEM IS FOUND BY COMPUTING A LOCATION COEFFICIENT FOR EACH POTENTIAL SITE USING TRANSPORT INPUTS AND TIME-DISTANCES. THE SECOND MODEL PROVIDES A SOLUTION FOR THE COMMUTER POST-SECONDARY EDUCATIONAL INSTITUTION. ECONOMIC EFFICIENCY OF ANY POTENTIAL SCHOOL LOCATION SITE WILL BE DEPENDENT UPON SPATIAL DISTRIBUTION OF STUDENTS, GEOGRAPHICAL TERRAIN, URBAN-RURAL CHARACTERISTICS OF THE REGION, AND NATURE OF ROADS AND ROADWAY NETWORKS. THIS PAPER WAS PRESENTED AT THE WESTERN REGIONAL SCIENCE ASSOCIATION MEETINGS (LAS VEGAS, JANUARY 27-29, 1967). (HW)

DETERMINATION OF THE LOCATION FOR AN AREA SCHOOL*

Jeanne Dost

I.

Society has become increasingly concerned about educational deprivation of youth in both urban and rural areas.[1] This recognition is concurrent with increased competition of other social needs for resources. In such circumstances it is particularly important that plans for expanding educational expenditures reflect considerations of economic efficiency.

Although federal funds have been provided to help school districts build area schools, decision-makers in education lack methodology for determining the best site for a school. Availability of objective guidelines could help prevent arbitrary and inefficient solutions to the area school location problem.

A model is presented in this paper to give educators and school systems a means for determining the most efficient site for an area school. Although no procedures have been developed for locating a school when the service area is defined, Isard has presented methods for analyzing determination of the most desirable administrative area given the location of a school.[2] Unfortunately he does not provide a solution to the problem. Correa has dealt with the question of optimum size and number of schools in terms of cost per student.[3] However, he assumes that quality of education is constant, at a time when, at least in this country, the quality of education is rapidly changing.

Funds for this work were granted by the U. S. Department of Health, Education, and Welfare; Office of Education.

[1]E. g. Social Dynamite: The Report of the Conference on Unemployed, Out-of-School Youth in Urban Areas. Washington, Nat. Comm. for Children and Youth, 1963. Rural Youth in Crisis: Facts, Myths, and Social Change. Washington, U. S. Dept. of Health, Education and Welfare, 1964.

[2]Walter Isard. Methods of Regional Analysis: An Introduction to Regional Science, pp. 527-533. Cambridge, Mass., The M.I.T. Press, 1960.

[3]Hector Correa. Optima for the Size and Number of Schools. Scientia Paedagogica Experimentalis, III, 1, 5-15.

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* Paper presented at the Western Regional Science Association Meetings, Las Vegas, Jan. 27-29, 1967.

II.

The purpose of this paper is to present an adaptation of comparative cost techniques for location determination of the transport-oriented plant to solving the problem of locating an area school based on a variation of Weberian methodology. Economic efficiency of any potential school location site will be dependent upon the spatial distribution of students, geographical terrain of the area, urban-rural characteristics of the region, and the nature of the roads and roadway networks. All these factors can be taken into consideration by a location coefficient computed for each potential site point.

The model will enable decision-makers to select that location at which regional education can be provided at minimum cost to youths dispersed over a wide area. The solution provided by the model maximizes the use of available educational resources by minimizing those costs assumed to vary with location --- time and transport costs of moving students to and from the school. The significance of this assumption is examined in the last section.

The model for solving the location problem in the case where only three alternative sites exist and school buses transport students is set forth in Section III. The general model for the bus transport case is developed in Section IV and transformed in Section V to handle the site problem of the commuter post-secondary educational institution.

III.

This model is posited on the assumption that the only variations in regional education costs created by changing school sites are changes in time and costs of transporting students to and from school. While time is generally treated as a non-monetary factor, it is included here as one determinant of the location of an area school by use of a time-distance factor. This methodology allows for the disutility of greater travel times so that of any two sites with identical transport costs, the optimum site would be that for which student travel time was less.

Travel time is taken into consideration by use of the concept of time-distance rather than geographical distance. This concept can best be explained by example. Where each of three sites are being considered as locations for an area school, assume sites b and c are each 20 miles from point a. However, the road between b and a is a freeway and no stops must be made to load (unload) students. Therefore, time for a school bus to travel from b to a is, say, 30 minutes. On the other hand, the road between c and a crosses mountain terrain and the school bus has to make a number of stops. Thus, it takes this bus one hour to travel from c to a. Comparisons of simple road distances would indicate points b and c to be equi-distant from site a. The concept of time-distance takes into account that it takes twice the time to travel from c to a as from b to a; the time-distance from c to a is twice that between b and a.

The formula for computing time-distance between i and j is:

$$\frac{t_{ij}}{m_{ij}} = p_{ij}$$

where:

t_{ij} = minutes of bus (automobile) travel time between any two points, i and j

m_{ij} = number of miles between points i and j

p_{ij} = minutes per mile for trip between i and j

so that

$$p_{ij} m_{ij} = d_{ij}$$

where:

d_{ij} = time-distance between any two points, i and j.

Transport inputs are the costs per mile for a bus to travel between any two points. Transport inputs are computed per bus rather than per student as it costs as much for the bus to travel between any two points whether or not it is filled to passenger capacity, since it can be assumed the school bus will make the trip even at times when some students are unable to go to school.[4]

These two factors, time-distance and transport inputs, are used to compute a location coefficient for each of the three potential sites.

Where alternative inter-point routes exist, only that for which transport input times time-distance is least would be used in computing the location coefficient. The location coefficient for point a is:

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[4] This is not strictly true since operating and maintenance costs of each bus will depend on the number of stops which in turn is a function of the number of passengers.

$$L_a = 2x(r_{ab} d_{ab}) + 2x(r_{ac} d_{ac})$$

where:

$2x$ = number of school buses making trips twice daily

r_{ab} = transport input for moving students from a to b

d_{ab} = time-distance between a and b

r_{ac} = transport input for moving students from a to c

d_{ac} = time-distance between c and a.

It follows then that total costs of an area school are minimized when the area school is so located that time and costs of transporting the student to and from the area school are minimized. The optimum location site would be at point a when:

$$L_c > L_a < L_b.$$

Ceteris paribus, total costs of the area school are minimized when the location coefficient for site a is less than the location coefficients of either b or c.

IV.

Where the number of possible alternative locations is larger than three, any potential site is designated by the subscript i, where $i = 1 \ldots n$, n being the number of alternative locations.[5] The location coefficient for any point i is:

$$L_i = 2x(r_{i1} d_{i1}) + 2x(r_{i2} d_{i2}) + \ldots. + 2x(r_{i(n-1)} d_{i(n-1)})$$

where:

r_{i1} = transport input for moving students from point i to alternative 1

d_{i1} = time-distance from point i to alternative 1

[5] In the case of strip cities, sites at either end of city would be treated as alternative sites.