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A METHOD FOR DETERMINING THE LOCATION OF PUBLIC ENTERPRISES

by

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ABSTRACT

As a tool for feasibility studies in the choice of location problem for public enterprises, a simple method for determining the location of these enterprises is developed using indicators of centrality levels of places together with an area delineation scheme.

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I. Introduction

The problem of the absence of choice of location criteria for public enterprises/projects is that it affords no comparison of feasibility studies for alternative sites. While it is not suggested here that feasibility studies must be made for all possible sites since this is too broad and costly work, it is however recommended that feasibility studies be made also at least for a few (say 2 or 3) other potential locations. The results of the benefit-cost analysis then can be compared and, in the absence of subjective factors, the site that satisfies the optimality criteria for feasibility studies would obviously be the most preferred site. It is therefore apparent that an important initial consideration in feasibility studies must be the provision of some method or guide in the choice of site or potential site with which feasibility studies for the site and other alternative sites can then be made.

The objective of this paper is to provide a method that may serve as guide in the choice of location (or potential locations) of the project in each of which feasibility studies may be made and compared. First, on the basis of central place theory, a method for the determination of the hierarchy of places is provided. Then, with the use of the centrality scores/indices and the distances between nodes, a method for delineating areas using a simple "gravity model,"[1] that enables the identification of area clusters and their respective centers will be provided. Finally, a scheme for choosing the potential location(s) among the different area clusters is provided.

II. Hierarchy of Central Places

Centrality as used in this study refers to the relative importance of functions offered in a place vis-a-vis those in other places within a given area. Functions are measured in terms of establishments from which goods and services are made available.

To arrive at some quantitative indicator of centrality, Marshall[2] devised a system of indexing which proceeds from the assumption that the level of centrality of a place is proportional to the number of establishments of a function in the entire system (set of places) with a combined centrality value of 100. A range of the type of functions is then defined. Given this range,

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[1] For a discussion of gravity type models, a borrowing from physics, see Harry W. Richardson, Regional Economics. (New York: Praeger Publishers, 1969), pp. 132-136.

[2] John M. Marshall, The Location of Service Town. (Toronto: University of Toronto Press, 1969).

occurrence of the functions in a given set of places is tabulated (presence or absence in absolute number) for each place.

Using the assumption that the total number of all functions in the entire system (i.e., all places) has a combined centrality value of 100, the weight of a function j is determined using the equation

$$C_j = t/T_j = \frac{100}{\sum_{i=1}^{n} f_{ij}} \qquad \text{(II-1)}$$

where C_j = weight of the jth function, $j = 1, 2, 3, \ldots m$, in the system

t = the combined centrality value of 100

$T_j = \sum_{i=1}^{n} f_{ij}$, where f_{ij} is the number of occurrence in the ith place of the jth function.

These weights indicate the relative rarity or ubiquitousness of a function in the system. The result is, given the range of the type of functions present in the system, those frequently occurring will have lower centrality values while rarer functions will have higher values. This is consistent with the notion in economics that abundance is associated with lower values (weights) while scarcity is associated with higher values.

The weights are then applied correspondingly on the tabulated occurrences of the various functions in each of the places in the system and summed, i.e., for the ith place, the place's centrality score or index is

$$S_i = \sum_{j=1}^{m} C_j f_{ij} \qquad \text{(II-2)}$$

Sets of weighted centrality scores/indices per place per function result from which an analysis of the sum of weighted centrality scores/indices of each is made in the following manner.

a) The places (say municipalities) are ranked on the basis of their respective sums of weighted centrality scores or indices, S_i.

b) The score differences of consecutively ranked places (starting with the highest score) are computed.

c) The hierarchy of centers is determined on the basis of sudden "jumps" or large gaps (differences) in the scores/indices, S_i.

The procedure explained above is applied to identify central places in the area under consideration. Information on the following suggested type of functions shown in Table 1 maybe gathered for the purpose. The list of functions in Table 1 does not pretend to be exhaustive. It is meant only to suggest the type of functions that maybe relevant in conducting feasibility studies.

Table 1

TYPE OF FUNCTIONS

1. Large Manufacturing Industries
2. Public and Private Markets
3. Warehouse/Storage Facilities
4. Engineering Industries
5. Industrial Estates
6. Commercial and Development Banks
7. Rural Banks
8. Ice Plants/Fish Landing Facilities
9. Sea Ports
10. Train Terminals
11. Agricultural Extension Center
12. Technical Centers
13. Manpower Training Centers
14. Agricultural Schools
15. Hospitals
16. Messengerial Services
17. Telephone/Telegraphic Services
18. Schools (at least high school level)/colleges/universities
19. Water Supply Stations
20. Power Supply Stations
21. Waste Disposal Facilities

III. Area Clusters/Delineations and Cluster Center

In determining the area clusters in a specific geographic space or area (e.g. a province), all nodes or places down to the smallest unit (e.g. poblaciones of municipalities or barrios/barangays/districts) are considered potential centers of the specific geographic space. The objective is to identify area clusters and their respective centers, based not on distance alone[3] but a combination of the centrality scores[4] and distance between the nodes in the geographic space and/or distance between the nodes and major provincial/regional centers. This combination is done with the use of a simple gravity model to capture the interaction between the nodes.

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[3] The idea behind the method was conceived sometime ago by the author from Milton E. Harvey's, "The Identification of Development Regions in Developing Countries," Economic Geography. 48 (July 1972) in which the "adjacency matrix" (matrix of "edge characteristics" in this paper) is defined in terms of roads or distances between the nodes. This definition has been used, on the author's suggestion, by his thesis advisee, Juan M. Ragragio in his Towards a Method for Delineating Regions for Planning and Program Implementation. (M.A. Thesis, U.P. School of Economics, May 1983).

[4] Instead of centrality indices/scores, one may use population or, perhaps, the best may be some measure of internodal trade volume, the data for which maybe very hard to obtain. Centrality indices through, may suffice on the ground that these may already capture the effects of population or internodal trade.

Having identified the nodes or major market centers in the area under consideration, the square "matrix" A is developed to have entries α_{ij} such that

$$\alpha_{ij} = \frac{S_i^* S_j^*}{a_{ij}}, \quad i, j = 1, 2, 3, \ldots, n \qquad \text{(III-1)}$$

where α_{ij} = "edge characteristic," in this case the index of interaction between the ith and the jth nodes;

S_i^* and S_j^* = the ith and the jth nodes' respective centrality indices; and,

a_{ij} = distance between the ith and the jth nodes.

Since regional centers may also have a "pull" effect, we choose one nearest potential regional center to constitute one of the nodes in the system. The diagonal of A has as yet no entries (so that strictly speaking A is not a matrix but just to give it a name, A is here called a "matrix").

Then, for the diagonal entries, choose for each row one potential area center among the cell entries in the row (i.e. among the j nodes) according to the following rule:

$$\beta_{ij}^* = \max(\alpha_{ij}), \quad i = j \qquad \text{(III-2)}$$

$$\beta_{ij} = \alpha_{ij}, \quad i \neq j$$

Thus for each row, β_{ij}^* becomes the diagonal entry. We call the resulting matrix the cell entries of which are defined by (III-2) matrix B.

From (III-2) it is clear that in a given row, the row's cell entries β_{ij} cannot be greater than the row's diagonal entry β^*_{ij}, i.e. for that row

$$\beta_{ij} \leq \beta^*_{ij} \qquad \text{(III-3)}$$

or $\dfrac{\beta_{ij}}{\beta^*_{ij}} \leq 1$

From this we can form a simple condition for clustering: any of the $j = 1, 2, 3, \ldots, n$ nodes in the ith row would choose for its cluster that which would satisfy the equality condition of (III-3). Call the ratio $\dfrac{1}{\beta^*_{ij}}$ in (III-3) C^*_{ij}, and define a diagonal matrix C such that its cell entries are:

$$C^*_{ij} = \frac{1}{\beta^*_{ij}}, \quad i = j \qquad \text{(III-4)}$$

$$C^*_{ij} = 0, \quad i \neq j$$

Finally, matrix D is obtained as the product of matrices C and B, i.e.

$$D = C \times B \qquad \text{(III-5)}$$

which will have cell entries

$$d_{ij} = \left(\frac{1}{\beta^*_{ij}}\right)\beta_{ij} \qquad \text{(III-6)}$$

Hence for any given row i where (III-3) holds, either

$$d_{ij} < 1 \quad \text{(III-7)}$$

or $d_{ij} = 1$

Thus for each row in D the cell entries (any of the $j = 1, 2, 3, \ldots, n$ nodes) in that row that satisfies $d_{ij} = 1$ will belong to a common cluster. The cluster center may then be determined by using either the centrality or the nodal interaction indices.

The resulting area clusters may overlap. There is however no apparent reason why the area delineation should be strictly non-overlapping in exactly the same manner that market areas could not have a zone of indifference. Since the objective here is to define potential sites where feasibility studies may be made, the problem concerning the overlapping of area clusters maybe disregarded.

If, however, it is desired that the area clusters are strictly nonoverlapping, the ways of eliminating the overlap maybe: (1) central functions may be considered in determining the relationship of a place to the different clusters, (2) consideration of the indices of interaction, and, (3) consideration of other economic (e.g. trade volume) and historical relationships between the nodes in the clusters in the cluster centers.

Finally, the question is: which of the area centers (with their corresponding clusters) may be chosen as the potentially ideal site(s)? Here we may sum up the nodal interaction indices in each of the clusters, rank these indices and the choice is made from among the clusters with the largest sums of nodal interaction indices. The potential location(s) will then be in the center of the chosen cluster(s). To pinpoint the exact location of the project, the process described in the method is repeated, this time however applying it to the cluster area's center in which the nodes are the lowest order places.

IV. Correspondence with Agro-production Based Delineations

If it is desired to see the correspondence of the area delineations resulting from the previous method to agricultural production for the purpose of looking into the extent of rural-urban linkages, we may use Librero's ecological approach to area delineations. He calls the resulting delineations "area isolates."[5] These areas, bounded by mountain ridgelines in fact correspond to watersheds with defined catchment areas.

It is, of course, possible that the area clusters generated by the method developed in this paper and Librero's area isolates

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[5] F. Librero, Area Isolates: Implementing a Concept, Third Approximation. (University of the Philippines at Los Baños, Laguna), 1979).

may overlap, i.e. they may contain more or less the same places (e.g. municipalities). The extent of the correspondence between the two different methods, however, maybe measured.

Let G be a given geographic area (e.g. a province); X, an area isolate, and Y, an area cluster, both being subsets of G. We want to see the extent of similarity (overlap), U, between X and Y. Thus we set

$$U = X \cap Y$$

Then, whichever of X and Y contains more places, the number of places becomes the denominator of the following measure of correspondence between the two methods:

$$Z = \frac{U}{V}(100\%)$$

where Z = correspondence coefficient which will vary between 0 and 100%

U = number of the same places contained in both X and Y

V = number of places in either X or Y

Thus the higher the coefficient, the closer is the result of the two approaches.

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