AN ANALYSIS OF ADMINISTRATIVE AREAS AND CENTRES USED

BY EIGHT HUMAN SERVICE AGENCIES IN

SOUTHERN ONTARIO

By

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A Thesis

Submitted to the Faculty of Graduate Studies

in Partial Fulfilment of the Requirements

for the Degree

Master of Arts

McMaster University

October 1967

ADMINISTRATIVE AREAS IN

SOUTHERN ONTARIO

MASTER OF ARTS (1967)　　　　　McMASTER UNIVERSITY
(Geography)　　　　　　　　　　Hamilton, Ontario

TITLE:　　Analysis of Administrative Areas and Centres used by
　　　　　Eight Human Service Agencies in Southern Ontario

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NUMBER OF PAGES:　vi,　　100

SCOPE AND CONTENTS:　This thesis describes the spatial arrange-
　　　　　　　　　　ment of eight human service agencies for
　　　　　　　　　　the case of Southern Ontario. Using the
　　　　　　　　　　location of the administrative centres and
　　　　　　　　　　the distribution of population, a measure
　　　　　　　　　　of the compactness of each area is derived.
　　　　　　　　　　This is the moment of inertia. The adminis-
　　　　　　　　　　trative centres are relocated within the
　　　　　　　　　　areas currently used in such a way as to
　　　　　　　　　　minimize the moment of inertia. This is
　　　　　　　　　　the optimal location of the centre. By
　　　　　　　　　　comparing the moment of inertia for the
　　　　　　　　　　optimal location and moment of inertia for
　　　　　　　　　　the actual location, an index of efficiency
　　　　　　　　　　for each administrative unit is calculated.
　　　　　　　　　　Using four variables a ranking of importance
　　　　　　　　　　of administrative centres is provided. The
　　　　　　　　　　approach is essentially quantitative.

ACKNOWLEDGMENTS

TABLE OF CONTENTS

LIST OF MAPS AND DIAGRAMS

LIST OF TABLES

CHAPTER I

I.1   Introduction

> "All states, with the exception of only the very
> smallest divide for purposes of internal
> administration into smaller units." Pounds.[1]

The purpose of this study is to describe and attempt to

explain the spatial arrangement of a group of politically oriented

agencies in Southern Ontario. The spatial arrangement refers speci-

fically to the various ways in which the area has been divided for

administrative purposes. The agencies can be defined as human service

agencies; they are among a group of agencies which have been created

by the Provincial Government to provide specific services to the pop-

ulation of Ontario. The eight human service agencies selected, are

felt by the writer to be representative of the larger group of human

service agencies.[2]

The agencies to be examined are:

1. Department of Economics and Development

2. Department of Education

3. Ontario Hospital Services Commission

4. Ontario Hydro Commission

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[1] N.J.G. Pounds, Political Geography, (New York: McGraw-Hill, 1963), p. 193.

[2] A list of human service agencies is provided in Appendix A.
Resource oriented agencies such as the Department of Mines, and the
Department of Lands and Forests, are not treated in this study. The
factors which influence the spatial organization of these agencies
contrast with those which influence the spatial pattern of human service
agencies.   The spatial organization of resource oriented agencies is
strongly influenced by the specific location of resources, whereas the
spatial organization of human service agencies is influenced by the
population distribution.

5. Department of Highways

6. Department of Transport

7. Department of Public Welfare

8. Ontario Provincial Police

The field of study has been narrowed from the whole of the Province of Ontario, to Southern Ontario. A line parallel to the French River, south of North Bay from the Grundy Lake Provincial Park to the Ottawa River, marks the northern limit of the study area. Though less than 12% of the area of Ontario is south of this line, over 85% of its population is found here. To the south the transportation network is more highly developed, settlement is more continuous and the arrangement of agencies more complex than to the north, where two or three centres (North Bay, Fort William and Timmins), and very large areas dominate the administrative pattern.

The study will attempt to define a quantitative measure of the spatial arrangement of administrative units used by the agencies. A survey of the literature relevant to this will be discussed in chapter two. Using the actual location and a theoretical location of the administrative centre, an index of efficiency, for each administrative unit, within each agency, will be calculated. This index is discussed in chapter three.

This research is also concerned with developing a technique for comparing the spatial arrangements of the agencies. If an agency has two or more regional divisions, the one nearest to ten will be selected, since this is closest to the number of regions used by the Department of Economics and Development. It was stated, in the course

of interviews, that the regionalization programme of this agency had influenced the regionization schemes of the other agencies. Ideally the spatial arrangements of the agencies should only be compared when they have the same number of administrative units. However the number of administrative units for the eight agencies varies from five to twelve (see page 47 chapter three). This study will develop a method for incorporating this variation into an index for directly comparing agencies. A resultant ranking of agencies will be provided in chapter three.

Chapter four will be concerned with a study of the administrative centres used by the agencies. A ranking of their frequency of use is offered. A summary of the research, and specific conclusions is presented in chapter five.

I.2 Review of the literature

The rationale for the statement by Pounds at the beginning of this chapter is provided by the assumption that the execution of Acts, passed by the state legislature, is made easier by dividing the state area into semi-autonomous units. Examination of the size, shape and functions of these units has attracted the attention of political scientists, economists, and political geographers among others.

Political scientists have focussed attention on political processes and behavior. And in their study of areal relationships some emphasis has been placed on socio-economic characteristics of the population occupying a particular location. Prescott[3], Kasperson[4]

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[3] J.R.V. Prescott, "The Function and Methods of Electoral Geography", Annals Association of American Geographers, Vol. 49, No. 3, (Sept. 1959), pp. 296-304.

[4] R.E. Kasperson, "Political Behavior and the Management of

and Cox[5] may be classed as geographers, but they have also devoted research to these fields. Fesler[6] notes that the number and average size of regions deemed desirable for the administration of a given agency is most closely related to the magnitude of the activity to be carried on in the field. This point is amplified in Johnsrud's[7] study of Wisconsin agencies. Fesler offers a summary of five factors to be given greatest weight in determining the number and size of regions.

1. The magnitude of field work.

2. The localization of the objects to be administered.

3. The capacity of the headquarters to supervise the regional chiefs.

4. The comparative results to be expected from large-scale and small-scale administration.

5. The implications of political influence on appointment of regional personnel.

He also notes that the determination of the exact boundaries of the regions should be based upon a consideration of the following four criteria:

1. Equalization of the burden of work.

2. The nature and distribution of the objects to be administered.

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natural Resources. An Inquiry into Cognitive and Decision-Making Processes", Unpublished paper presented at the Annual Conference of American Geographers, St. Louis, 1967.

[5]K.R. Cox, "The Contextual Model as a Spatial Interactional Model for Political Geography", Unpublished paper presented at the Annual Conference of American Geographers, St. Louis, 1967.

[6]J.W. Fesler, "Criteria for Administrative Regions", Social Forces, Vol. 22, No. 1 (1943-44), pp. 26-32.

[7]R.O. Johnsrud, "Areal Relationships in the functioning of Wisconsin State Agencies", (Unpublished Ph.D. dissertation, Department of Geography, Madison, Wisconsin, 1958).

3. The administrative areas used by cooperating agencies.

4. The disadvantages of changing existing boundaries.

Finally he states that the location of administrative centres must take into account the following factors:

1. The location of objects of administration within the region.

2. The location of the headquarters of other agencies.

3. The availability of office space.

4. The need for frequent personal contacts between the headquarters and the regional offices.

The size and shape, as well as the stage of development, of the state area strongly influences the effect of the last factor mentioned above. The development of an intense network of telephone communications in Southern Ontario, has obviated much of the need for frequent personal contacts between the headquarters and the regional offices. The road system of this part of Ontario is well developed, and when personal contact is necessary, rapid access to most settled places is available.

In some recent papers by political scientists there has been a move away from a consideration of the spatial aspects of administrative areas. Ostrom[8] for example, expresses the complexity of regional analysis of politics in terms of an intimate connection between behavior and policy-formulation. He considers that the traditional institutional referents used in political science such as councils, agencies, and departments, are not adequate to serve as a basis for

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[8]V. Ostrom, "The Political Dimensions of Regional Analysis", Papers and Proceedings of the Regional Science Association, Vol. II, 1956, pp. 85-97.

investigating the activities, relations and behavior involved in policy-formulation in the non-corporate region. With this in mind the geographer can serve a very useful purpose in examining the spatial aspects of political units, and so add to the general understanding of political activities.

Economists have maintained their traditional view towards administrative areas, that is they use cost-analyses techniques to evaluate the efficiency of administrative functions which occupy a defined space. Optimal shapes and sizes for administrative areas have been suggested by Christaller[9] and Lösch.[10] The hierarchy of Central Places postulated by Christaller has an explicit pattern which satisfies his demand for maximum administrative efficiency. The K-7 network was based on an optimal administrative structure. The advantages of using Central Place theory to delimit functional areas have been recently outlined by Christaller.[11] In his application of the theoretical model of a spatial administrative system he considers it necessary to:

".. consider features of the terrain, the network of natural
waters, densities of population, existing settlements, traffic
routes, and last but not least, the anticipated trends of
future development and politically desirable planning
objectives."[12]

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[9]W. Christaller, Central Places in Southern Germany, (Translated from Die Zentralen Orte in Süddeutschland, C.W. Baskin, 1966), (New Jersey: Prentice-Hall, 1966), pp. 77-80.

[10]A. Lösch, The Economics of Location, (New Haven: Yale University Press, 1954), pp. 124-134.

[11]W. Christaller, "The Advantages of Space Economical Theory for the Practice of Regional Planning", Ekistics, Vol. 20, No. 119, 1965, pp. 223-227.

[12]W. Christaller, Ibid, p. 224.

The wide range of variables outlined above have been recognized, on an a priori basis, as influencing the spatial arrangement of administrative agencies. Tests of their influence are found in the works of Johnsrud,[13] Whebell[14] and Lewis.[15] The most recent study by Lewis lays emphasis on the changing role of transportation and communications through time. In the 1940's Dickinson[16] attempted to examine administrative areas as they varied through both time and space. He concentrated on some spatial administrative functions in France, Germany and Britain. Harris[17] offered a more comprehensive summary of the systems of local government in different parts of the world. His work is dated mainly because it was completed before the large-scale introduction of inter-municipal and ad hoc planning boards which have largely been a feature of post 1945 politics. Dolbey[18] has studied the role of inter-municipal districts in Ontario and concluded that the present system is inefficient. Like Krueger[19] she recommends a "new styled county" as the

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[13]R.D. Johnsrud, op. cit.

[14]C.F.J. Whebell, "The Geographical Basis of Local Government in Southern Ontario", (Unpublished Ph.D. dissertation, University of London, U.K., 1961).

[15]J.E. Lewis, "Functional Regions of the U.S. South: their expansion in relation to transportation change," (Unpublished Ph.D. dissertation, University of Georgia, 1966).

[16]R.E. Dickinson, City Region and Regionalism, (London: Kegan Paul, 1947).

[17]G. Montague Harris, Comparative Local Government, (London: Hutchinson, 1948).

[18]S.J. Dolbey, "Inter-Municipal Special Purpose Bodies in the Province of Ontario", (Unpublished M.A. dissertation, Queen's University, 1965).

[19]R.R. Krueger, "Regional Economic Development in Ontario", The Municipal World, Vol. 75, April, May, June, 1965. (Three issues).

fundamental governmental spatial unit. The inefficiency noted by Dolbey is, to some extent, a product of the hierarchy of spatial units presently used. The concept of a hierarchy, among the arrangement of units, has been noted by Pounds.[20] In general terms he claims this hierarchy exhibits a gradation in functions and responsibilities. With reference to Ontario, the arrangement of incorporated municipalities does exhibit such a gradation in functions and responsibilities. The administrative areas used by the agencies to be examined in this study are de jure equal.

The earlier studies of boundaries as interfaces between political systems have been refined by political geographers to include intrastate boundaries, where a functional or service area is delimited. The concept of areal functional organization has been incorporated into Central Place studies, and in the publication by Berry and Pred[21] a selection of references in this field is included. Within the sphere of political geography Brown's[22] study and the one by Johnsrud[23] have both developed from the principles defined by Hartshorne[24] in 1950.

[20] N.J.G. Pounds, op. cit., chapter 8, pp. 193-221.

[21] J.L.B. Berry, and A. Pred, Central Place Studies, Regional Science Research Institute, Bibliography Series Number One with Supplement, (Philadelphia, 1965).

[22] R.H. Brown, "Political Areal-Functional Organisation", Research Paper Number 51, Department of Geography, University of Chicago, 1957.

[23] R.O. Johnsrud, op. cit.

[24] R. Hartshorne, "The Functional approach in Political Geography", Annals Association of American Geographers, Vol. 40, No. 2. (June, 1950), pp. 95-130.

Philbrick[25, 26] has also focussed attention on the functional
approach to political geography. An understanding of some of the
aspects of the functional political geography of sub-national govern-
mental units is offered in this work. By concentrating on purely
administrative aspects of the provincial agencies, rather than dealing
with all three, legislative, judicial and executive (this includes ad-
ministrative), this study emphasises those aspects of agency operation
that are most concerned with the organization of space.

There is a body of literature on administrative areas which is
the product of planners in both the academic and non-academic worlds.
Research varies from the "general equilibrium"[27] models developed by
Lösch[28] and Christaller[29] through studies by Isard[30] which attempt to
incorporate the mobility of goods, services and people into regional
analyses. These studies are largely theoretical. Finally there are

[25]A.K. Philbrick, "Principles of Areal Functional Organisation
in Regional Human Geography", Economic Geography, No. 33, (1957),
pp. 299-336.

[26]--------, "Areal Functional Organisation in Regional Geog-
raphy", Papers and Proceedings of the Regional Science Association,
Vol. III, 1957, pp. 87-98.

[27]M. Chisholm, Rural Settlement and Land Use, (London:
Hutchinson, 1962), pp. 11-20. A discussion of types of location
studies and the concepts of partial equilibrium and general equili-
brium analysis is presented in the Introduction (pp. 11-20).

[28]A. Lösch, op. cit.

[29]W. Christaller, op. cit.

[30]W. Isard, Location and Space Economy, (New Haven: Yale
University Press, 1954).

numerous empirical studies, in the form of local, national or supra-
national plans. With reference to Canada, local and national plans
are discussed in Regional and Resource Planning in Canada.[31]

Fundamental to both empirical and theoretical studies is the
concept of transportation cost. This will be operationalized in this
study. It will be incorporated into a technique for relocating adminis-
trative centres. Friedmann[32] is among a group of Regional Scientists
who have written on this concept; he considers that transportation cost
is one of the variables which influences a spatial distribution.
Through time the power of this variable has changed. Where a primitive
stage of development of transportation is in evidence, the area sur-
rounding a village or town, which comes under its political influence,
tends to be limited. The growth of city-states, in classical times,
was largely a product of parochial forces. These forces continued in
Europe in medieval times and even today several city-states remain.[33]
During the colonial period in Canadian history a similar phase was in
evidence; a phase in which centres grew and developed in response to
road communications to nearby farms. The growth and delimitation of
townships depended primarily on accessibility to centrally located
villages or towns. Whebell's[34] thesis considered the early phases in

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[31]R.R. Krueger, (Senior Editor), Regional and Resource Planning
in Canada, (Toronto: Holt, Rinehart and Winston, 1963).

[32]J. Friedmann, "Regional Planning: A Problem in Spatial
Integration", Papers and Proceedings of the Regional Science Assoc-
iation, Vol. V, 1959, pp. 167-169.

[33]N.J.G. Pounds, "The Persistence of the City-State", Unpub-
lished paper presented at the Annual Conference of the Association of
American Geographers, St. Louis, 1967.

[34]C.F.J. Whebell, op. cit.

the development of human settlement in Southern Ontario. He recognized

corridors of movement and nodes or focal points. With improved communica-

tion systems, growth of population and the relative ease with which

Southern Ontario could be settled, it is evidenced that the corridors

of movement have not only been reinforced, but considerably enlarged

in terms of total population growth. Commuter traffic follows daily,

weekly, and to a growing extent, seasonal cycles. But fundamental to

all cycles is the increasing ease of personal mobility in Southern

Ontario.[35]

Future research could be concerned with a detailed examination

of the patterns of circulation,[36] and to this end linkage and flow

analysis could be employed.[37, 38, 39] This would help in the fuller

understanding of the patterns of behavior, the use of space, and the

evaluation of administrative structure in Southern Ontario.

Movement of goods, services and people is influenced by the

level of economic development of the area. Friedmann[40] considers that

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[35]Department of Highways, A Plan For Ontario Highways, Department
of Highways, Toronto, December 1956, pp. 13-15 and pp. 23-25. The flow
charts published by the Department of Highways support this statement.

[36]J. Gottmann, "The Political Partitioning of Our World, an
attempt to Analyse", World Politics, Vol. IV, No. 4, 1952, pp. 512-19.

[37]M.E. Garnsey, "The Dimensions of Regional Science", Papers and
Proceedings of the Regional Science Association, Vol. II, 1956, pp. 27-39.

[38]P. Haggett, Locational Analysis in Human Geography, (London:
Arnold, 1965) pp. 40-55.

[39]K.J. Kansky, "Structure of Transportation Networks", Research
Paper Number 84, Department of Geography, University of Chicago, 1963.

[40]J. Friedmann, op. cit., p. 175.

major nations in the world today "see as one of their goals the complete spatial integration of their political economy". As Rostow[41] formulated stages in national economic growth so Friedmann has outlined steps in the internal structuring of transportation networks, resource surveys, and capital investments. Southern Ontario, within the context of the Province and the State, has a very high level of development in terms of transportation networks, resource surveys and capital investment.

I.3   Regional Planning and Administrative Areas

To achieve some of the aims outlined above, Regional Planning has been applied. It has not enjoyed a history of success. Rather its ad hoc usage and fundamental pragmatism have led to a multiplicity of planning agencies and bodies. Ontario is no exception to this general statement. Commenting on this, with respect to Southern Ontario, Krueger[42] noted the multiplicity of sub-regions and districts, and the need to reappraise the administrative areas of agencies whose policies affect the economic development of the Province and the State. More explicitly the Prime Minister[43] stated, with respect to regional activities of Government Departments and Agencies:

> ". . . in order to achieve better coordination of government
> regional activities, Ontario government departments and
> agencies will work towards the adoption of common adminis-
> trative areas. At the very minimum, common geographical
> units will become the basis for developing departmental
> regional structures."

[41]W.W. Rostow, The Stages of Economic Growth (Cambridge: Cambridge University Press, 1960).

[42]R.R. Krueger, op. cit.

[43]Prime Minister, "Design for Development", Statement by the P.M. of the Province of Ontario on Regional Development Policy, April 5th, 1966.

It is the view of Prescott[44] and Logan[45] that internal boundaries can be varied according to the needs of the State. Not infrequently however conservatism and local sentiment are invoked when local boundary changes are recommended.[46]

Explicit definitions for the optimal arrangement of administrative areas have been outlined by Dickinson.[47] He considers that the local administrative area

> "should be determined primarily on the basis of accessibility to a town. The leading idea in the creation of new units is that they should be compact, with a rough equality in area and population, each with its chief administrative centre in the geographical centre and with its frontiers in thinly populated areas which are divided between local associations."

More recently Prescott[48] stated that boundary reorganization should be guided by the following principles:

> 1. All government areas should be composed of aggregates of the smallest basic unit, in such a way that the boundaries are multi-functional.

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[44] J.R.V. Prescott, The Geography of Frontiers and Boundaries, (London: Hutchinson, 1965), p. 153.

[45] W.S. Logan, "The Evolution and Significance of Local Government Boundaries in Southwestern Victoria", Australian Geographical Studies, Vol. IV, No. 2, (October 1966), pp. 154-170.

[46] R.J. Mowitz, "Evaluating Costs and Benefits of Intergovernmental Relations", Community Development: Problems and Prospects, Editors R.L. Buck and R.A. Rath, (Pennsylvania, State University of Pennsylvania), 1965, pp. 65-72. Values attached to local boundaries by groups and individuals are examined in this paper.

[47] R.E. Dickinson, op. cit., pp. 34-35.

[48] J.R.V. Prescott, op. cit., 1965, p. 173.

2. Conurbations should be constituted into single administrative areas capable of coordinating development.

3. Boundaries should follow watersheds, to avoid unnecessary divisions of water, roads and sewage services, which usually follow valleys.

4. The boundary should be drawn to cater for local sentiment and regional patriotism.

These ideas are in agreement with the suggestions of Fawcett,[49] Gilbert[50] and Taylor.[51]

With respect to Southern Ontario Whebell[52] attempted to combine variables to produce areas where a district political organizational structure would be possible. He used:

1. Physical zones

2. Urban service areas

3. Areas of declining population

4. Administrative "shear lines"

to construct a map of the spatial organization of governmental units in Southern Ontario. He did not use quantitative techniques to combine the variables, or to test their influence on each other. A multi-variate technique for locating regions in Ontario has been applied by

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[49]C.B. Fawcett, Provinces of England, 1919, New Edition by W.G. East, and S.W. Wooldridge, (Editors), (London: Hutchinson, 1960).

[50]E.W. Gilbert, "Practical Regionalism in England and Wales", Geographical Journal, Vol. 94, No. 1, (July 1939), pp. 29-44.

[51]E.G.R. Taylor, "Discussion on the Geographical Aspects of Regional Planning", Geographical Journal, Vol. 99, No. 1, (Jan. 1942), pp. 61-80.

[52]C.F.J. Whebell, op. cit.

Ray.[53] The theory underlying this technique was developed by Berry.[54] Zobler[55, 56] also offers a method for examining regional structures.

In this study of agencies in Southern Ontario it is recognized that the agencies operate in response to a static physical environment and a complex group of dynamic forces, notably those influencing the spatial mobility of the population. The variety of physical types has been examined by Putnam and Chapman,[57] and some of the industrial, and population flows have been treated by Ray.[58] Interaction between Ontario and Quebec has been examined by Mackay[59] and that between Southern Ontario and U.S.A. by Ray.

The concept of the "city-state" has been mentioned earlier in this chapter. Recently it has been updated to the "city-region", and in this form it has been applied to the planning of administrative areas. Two studies from the U.K. employ the "city-region" concept. Senior[60]

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[53]D.M. Ray, "Market Potential and Economic Shadow: a Quantitative Analysis of Industrial Location in Southern Ontario", Research Paper Number 101, Department of Geography, University of Chicago, 1965.

[54]B.J.L. Berry, "A Method for Deriving Multi-Factor Uniform Regions", Przeglad Geograficzny, t, xxxiii, z.2, 1961, pp. 263-79.

[55]L. Zobler, "Statistical Testing of Regional Boundaries", Annals Association of American Geographers, Vol. 47, No. 1, (March 1957), pp. 83-95.

[56]--------, "Decision-Making in Regional Construction", Annals Assoc. American Geographers, Vol. 48, No. 2, (June 1958), pp. 140-8.

[57]L.J. Chapman and D.F. Putnam, The Physiography of Southern Ontario, (Toronto: University of Toronto Press, 1966), Second Edition.

[58]D.M. Ray, op. cit.

[59]J.R. Mackay, "The Interactance Hypothesis and Boundaries in Canada — a Preliminary Study", Canadian Geographer, Vol. 4, No. 1, pp. 1-8.

[60]D. Senior, "The City Region as an Administrative Unit", Political Quarterly, No. 36, pp. 82-91.

defines the "city-region" as the area whose inhabitants look to a common centre for those specialised facilities and services whose economic provision demands a user population of large, but less than national proportions". He states that:

> "the emergence of this entity (city-region) has been brought about by such trends as increasing personal mobility, fertility, affluence and leisure, by technological advances in industry, agriculture, transport and communications, and by the consequent development of a mass culture. These trends have resulted in the assimilation of urban and rural life; in the loosening of local ties, the complication of social relationships and the widening of horizons; above all, in the dispersal of homes, workplaces and everyday service facilities from congested towns to a cleaner and more spacious surroundings. I submit that we ought to look down and see how a regional structure can provide a better framework for local government".[61]

Griffiths[62] considers "welfare", "health", "town and country planning" and "highways", in the light of the great number of administrative units found in Britain. A recommendation for thirty-two centres and districts is offered. Senior recommends "about thirty". These new districts should be multi-functional, and responsible for planning, education, roads, health, and children's services. They should form the new shape of local government.

I.4 Summary

A review of the literature indicates that administrative areas appear to be delimited according to several principles. This study will examine eight agencies, and attempt to define those principles which were probably considered by the decision-makers when the areas were designated.

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[61] D.Senior, (Ed.), The Regional City, (London: Longmans, 1966) p. 16.

[62] J.A.G. Griffiths, "A new shape for local Government", New Society, Vol. 6, No. 160, 1965, pp. 7-9.

The present arrangement of the administrative areas will be quantitatively examined. This will allow the spatial patterns of the agencies to be compared. Finally an optimal location for the administrative centre will be defined and maps, showing the optimal and actual location for each agency, will be drawn.

It is postulated that the distribution of the population plays a major part in influencing the spatial arrangement of administrative areas, and the location of the administrative centre.

CHAPTER II

This chapter will be concerned with the theoretical construction of a model of a political administrative system. The rationale for selecting the variables and the ways in which they are treated, will be discussed. Quantitative techniques will be used for building the model. General comments on quantitative methods, as applied to the study of administrative areas and political geography, will also be included.

2.1 Quantitative Techniques and Administrative Areas

The three disciplines, political science, economics, and political geography, mentioned in chapter one as being interested in the study of administrative areas, have employed, in varying ways, and to different ends, some of the many statistical techniques available to the researcher. Janda's[1] work in political science gives a full treatment of certain quantitative techniques, whereas Alker's[2] book is more general, and considers the application of mathematical concepts to political, and more particularly human behavior.

Economists have long employed graphics to solve some of their problems. From the outset of high-speed computation they have utilised

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[1]K. Janda, Data Processing, Applications to Political Research, (Evanston: Northwestern University Press, 1965).

[2]H.R. Alker, Mathematics and Politics, (New York: The Macmillan Company, 1965).

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the techniques which can simultaneously consider large quantities of data. Linear programming, for example, was first employed to solve economic problems of choice, where costs and benefits, surpluses and deficiencies could be defined, and alternative solutions offered.

Political geographers are becoming increasingly aware of research methods used by their colleagues in other disciplines. Quantitative techniques have been a keynote in some recent papers. New approaches to traditional problems are suggested as the emphasis moves from subjective to objective analysis of political situations. Cox,[3] for example, stresses that if political geography is to be integrated into geography as a science with the emphasis upon rigour in drawing up hypotheses, hypothesis testing, and theory construction, then it is likely that studies of areal variation in the levels of different political activities will play an important role in this integration. He uses a model developed in sociology and political science and extends it in a spatial manner, so that it can be employed in studies of the areal variation of political activities.

The spatial approach, in urban and economic geography, has been possible because of the availability of data descriptive of economic activities for discrete points which can be given unambiguous locations, and also because of the availability of flow data for commodities, labour, capital etc.. Political geography, in its studies of areal variations of political activities, is constrained by the collection of data for areally extensive units, and by the absence of flow data relevant for political activities.

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[3]K.R. Cox, op. cit.

Soja[4] uses a quotation by Deutsch[5] to underline his own research.

> "The study of quantitative densities of transaction is the first step towards estimating the degree to which people are connected with one another."

By measuring the flow of telephone traffic an attempt is made to assess the level of integration of groups in East Africa.

The recent research by Reynolds and McNulty[6] is concerned with the study of barriers to human interaction. They attempt to do more than record disputes or develop taxonomies; they try to measure the relative barrier effects of boundaries on various types of interaction. They claim that a spatio-behavioural approach to model building in boundary research can provide the basis for a better understanding of the impact of boundaries on human behaviour.

The quotation by Soja gives an excellent statement of intent for the political geographer.

> "Political geographers have long recognized that a primary function of any politically organized area is to integrate effectively its territorial components; there has been little systematic research directly related to the measurement and analysis of political integration within a spatial context. This is a complex problem involving a wide range of social, psychological and economic as well as political variables. Recent developments in various branches of economic geography have shown that tools are available to handle complex multivariate phenomena, and more importantly, many

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[4] E.W. Soja, "Transactional Flow Analysis and Political Integration in East Africa", Unpublished paper presented at the Annual Conference of American Geographers, St. Louis, 1967.

[5] K.W. Deutsch, "Communication Theory and Political Integration", in P.E. Jacob and J.V. Toscano (Eds.), The Integration of Political Communities, (Philadelphia: J.B. Lippincott Company, 1964), p. 51.

[6] D.R. Reynolds and M.L. McNulty, "Political Boundaries, Barrier Effects, and Space Perception", Unpublished paper presented at the Annual Conference of American Geographers, St. Louis, 1967.

scholars from other disciplines have become increasingly
involved in the study of political integration, contributing
much that is of interest to the political geographer."[7]

Problems relating to gerrymandering and political representation
have been quantitatively examined by Bunge,[8] Silva,[9] and Weaver and
Hess.[10] Bogue's[11] paper contains several clear ideas which must be con-
sidered when dealing with either nodal or homogeneous functional areas.
The use of multiple regression analysis, to incorporate many variables,
and analysis of variance, to test for variations among regions, are
two techniques, recommended by Bogue, which can be used to help in the
description of regionalization systems.

2.2 Administrative Areas in Southern Ontario

This section will offer a qualitative analysis of the criteria
used by the agencies to delimit administrative areas and to locate ad-
ministrative centres. Correspondence and interviews, with official
representatives of the agencies, yielded the data for the study. The
interviews and questionnaires were "open-ended" and "unstructured".[12]

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[7]E.W. Soja, op. cit.

[8]W. Bunge, "Gerrymandering, Geography, and Grouping", Geograph-
ical Review, Vol. 56, No. 2, 1966, pp. 256-263.

[9]R.C.Silva, "Reapportionment and Redistricting", Scientific
American, Vol. 213, No. 5, Nov. 1965, pp. 20-27.

[10]J.B. Weaver and S.W. Hess, "A Procedure for Non-Partisan
Districting: Development of Computer Techniques" The Yale Law
Journal, Vol. 73, Dec. 1963, pp. 288-308.

[11]D.J. Bogue, "Nodal Versus Homogeneous Regions, and Statistical
Techniques for Measuring the Influence of Each", Bulletin de l'Institut
International de Statistique, Tome 4eme Livraison, 1957, pp. 377-392.

[12]C. Selltiz, M. Jahdda, M. Deutsch, and S.W. Cook, Research
Methods in Social Relations, (Toronto: Holt, Rinehart and Winston, 1964),

In general terms the basic administrative political unit in Southern Ontario is the township. Groups of contiguous townships have been combined together to form the administrative units used by the agencies. In some cases these administrative units are also groupings of counties. In the case of the Ontario Hydro Commission ten townships have been divided between adjacent administrative units.[13]

Department of Economics and Development

The plan to divide the Province of Ontario into Economic Regions was conceived at the first Conference on Industrial Statistics, convened by the Ministry of Planning and Development in February 1947. The normal political divisions of Ontario, consisting of forty-three counties and eleven districts, were deemed too numerous to make satisfactory statistical units. It was thought that larger areas would simplify the process of gathering and utilizing statistics. Tables and county-outline maps, which detailed the location of industry, the urban-rural population ratio, the distribution of gainfully occupied persons according to major industrial groups, types of agricultural production, lines of communication, commuting areas, public project areas, and estimated market areas, were produced. Contiguous counties possessing similar economic structures were combined, and a system of nineteen economic regions was evolved.

"Types of Interviews and Questionnaires", page 255. Appendix B contains a list of official representatives of the agencies who provided the data for this section.

[13]For the quantitative analysis, the whole township has been assigned to the administrative unit with the nearest administrative centre.

In the 1950's a revised scheme divided Ontario into ten economic regions to fit into an overall plan for Canada. These regions have been further sub-divided into economic zones. The provincial economic regions are, in all cases, combinations of counties, the basic statistical unit of the province.

During 1954 the Ontario Department of Planning and Development initiated a regional development programme for the province. This scheme was based on the revised provincial economic regions. Each regional conference area coincided with an economic region, with the exception that two regions in south-west Ontario were combined to form one regional conference area.

This modified version of the economic regions was adopted by the Ontario government as a basis for the establishment of Regional Development Councils. The primary objective of these Councils is the overall betterment of the region.

These regions are used for administrative purposes by other organizations: the Community Planning Association, the Ontario Labour Relations Board, and the Alcoholism and Drug Addiction Research Foundation.

The large and varied selection of papers presented at the conference sponsored by the Department of Economics and Development in 1965, stress that in the future new criteria may be selected for delimiting economic regions. The Department of Economics and Development also suggest that economic regions must have administrative links with the regional systems used by other agencies.

Department of Education

During 1965 and 1966 the Department of Education underwent major re-organization. The Hon. William G. Davis described the objectives of re-organization as two-fold.

> ". . . first, to streamline the organization of the Department for more efficient and effective operation in an era of rapid change and great expansion; second, to recognize more clearly the increasing emphasis on technical and vocational training throughout the entire programme of the Department."[14]

To achieve these objectives it was decided to decentralize the organizational structure, and re-allocate areas to local authorities. Decisions related to local needs and conditions, formerly made at Queen's Park, were to be made at the District level. Ten administrative Districts were delimited.

The Minister made explicit reference to the provision of 'better service', as a result of re-organization. Implicit in his statements is the assumption that the shape of the Districts is related to the distribution pattern of the population in the Province.

Ontario Hospital Services Commission

As part of a comprehensive planning programme for the organization of hospital beds and services for the population of Ontario, the Commission has divided the province into Referral Regions. Most of the centres of these regions are located near universities which can provide specialized types of care. The main objectives of the Commission's regionalization programme are:

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[14] W.G. Davis, "Re-organization of the Department of Education" Information Branch, Ontario Department of Education, Toronto, January 7th, 1965.

    i   to meet the hospital needs of the community as
        a whole by making necessary beds and services
        available to provide high quality care;

   ii   to eliminate unnecessary duplication of beds and
        services;

  iii   to permit maximum utilization of professional
        and technical personnel; and

   iv   to achieve these with the greatest economy of
        financial resources.

The three levels in the organization of hospital services
are the community, the district, and the region. The community is
the local level. To integrate the work of the three levels in the
provision of hospital services, an organizational framework is being
evolved. Under this system, each community will establish a council
which will review hospital and related health matters in its local
area and report these to a district council. The district council
will then try to integrate the needs of all the community councils
reporting to it. As soon as the programme for the district has been
defined, it will be presented to a regional council so that it can be
incorporated into a regional plan along with other district recommenda-
tions. Under this system, it is further envisaged that the regional
council will in turn present the final plan to the Commission, so that
it can be considered in relation to the programmes proposed by other
regional hospital councils.

Planning Councils which operate within the Provisional Regional
Planning Areas, have been established in Windsor-Essex County, Sudbury
District, Metropolitan Toronto, Bruce County, Hamilton and district,
St. Catharines-Lincoln County, and Ottawa, and one is being organized
in Sault Ste. Marie.

At the present time there are two parts of Southern Ontario where Referral Regions and Provisional Regional Planning Areas are not coincident. The two parts are the Kitchener-Guelph-Owen Sound area, and the Peterborough-Lindsay area. As far as the former area is concerned, it was thought that this might in time come more into the sphere of influence of Hamilton as the medical school at McMaster University develops. At present, the southern sections of Waterloo and Wellington Counties do send some regional patients to Hamilton, while the southern parts of Bruce and Grey Counties send less complicated cases to Kitchener and Guelph. The Commission also considered that it seemed not unreasonable to include the whole corridor in the provisional Hamilton Region. The Commission have placed the Peterborough-Lindsay area in the Kingston Referral Region. They feel that Peterborough might have a more important role with Kingston than with Toronto. Kingston might benefit if, in time, more patients were referred for care to the Kingston teaching hospitals.

Hospital planning involves the development of a programme to meet the bed needs of the Province. In the determination of active treatment bed needs, the Commission categorizes hospital centres in accordance with the level of diagnostic and therapeutic services they provide. These are defined as follows:

    i   Community centres which contain hospitals having usually less than 100 beds. These care for maternity cases, less complicated medical cases and surgical cases of a relatively minor nature.

    ii District centres which contain hospitals having in general from 100 to 500 beds. They can render more complicated care because of more specialized staff and facilities; they supply their own needs on the community level, and also accept some referral cases from nearby community hospitals.

iii   Regional centres which are usually university
       teaching centres. These hospitals are equipped
       and staffed to provide very specialized treatment
       such as heart surgery, brain surgery, cancer
       clinic work and so on, and thereby are able to
       accept cases referred from both community and
       district hospital centres.

Service areas for each hospital centre are delineated on the basis of this three-tiered system. Thus, while a community centre is surrounded by a community service area only, the regional centre is surrounded by all three. Of primary importance in this delineation are the admission-discharge forms submitted to the Commission for all patients separated from hospital. The information on these forms makes it possible to learn the origin and destination of patient movement, and the volume of patients involved. Each township area, that is the municipal township and the urban communities located spatially within each, is considered individually. Groups of contiguous townships, with similar patterns of hospital usage, are combined to form Referral Regions.

In areas where the population is relatively much older than the provincial average, more beds are required when needs are weighted to age, while in younger areas, fewer beds are needed. Age refined standards are applied to the particular age composition of the service area under study. Other factors, considered by the Commission, when they define Referral Regions are, the proposed expansion of hospital facilities, and the use of hospitals located near provincial boundaries which cater for the needs of out-of-province residents.

In summary, the distribution pattern of the population, and the patterns of movements of patients, appear to influence the size and

shape of the administrative units used by the Ontario Hospital
Services Commission.

Ontario Hydro Commission

A study of the development of the Ontario Hydro Commission's
regionalization programmes over the past sixty years indicates that
the Commission's history has been one of continuous accommodation to
administrative and technical conditions, as these have changed from
time to time. In 1947, when the regional organization was first under-
taken, a division of the province into nine regions was deemed to be
satisfactory. It has not been possible to trace the evidence used in
reaching this decision. The Commission have stated that subsequent
developments indicate that seven regions are sufficient, and considera-
tion is being given to reducing the number to six.[15]

Throughout the Commission's history there has been a continuous
process of areal amalgamation within the regions, and to some extent
a corresponding transfer of areas among the regions. The size of the
regions has also expanded as the demand and the supply of electricity
have increased.

The location of power supplies, the location of the demand
and the system for servicing equipment, as well as the power trans-
mission capacity, all appear to have influenced the size and shape of
the administrative units. In general terms, as efficiency in the
transmission of power and the servicing of the equipment has increased,
so the size of the administrative units has increased.

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[15]In an informal interview with an employee of the O.H.C. it
was mentioned that improved communications, both in terms of the move-
ment of power and the movement of equipment and personnel, are dominant
in the decisions to reduce the number of administrative regions.

Department of Highways

The Department of Highways has divided the province into eighteen administrative districts. The district boundaries usually follow the county boundaries and the objective, in determining the size of administrative units, has been to assign approximately the same number of miles of road to each District.[16]

Two studies, 'A Plan for Ontario Highways', dating back to 1956,[17] and the companion study, 'Ontario's Roads and Streets',[18] published shortly after, were the forerunners of a new type of study which the Department has had under way since 1963, namely Area Planning Studies. The eighteen administrative Districts are used as study areas. The first study, the Niagara Peninsula Planning Study, has been completed. By March 1966 eight other studies were in progress.

There is a significant difference between the earlier research techniques, in this Department, and these recent studnes. The earlier studies focussed attention on examining and making an inventory of the existing facilities. The Area Planning Studies seek to discover, for the study area, where the people are heading, why and by what route. Origin-destination studies have been conducted and form the basis of Area Planning Studies.

It was suggested to the writer by the Department, that the shapes of the Districts were chosen in an attempt to maximize internal

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[16]The Department of Highways do not state whether all roads are considered to be equal in terms of vehicle capacity or rate of flow.

[17]Ontario Department of Highways, A Plan for Ontario Highways, The Department of Highways, Toronto, 1956.

[18]Ontario Department of Highways, Ontario's Roads and Streets, Toronto, 1958.

interaction and minimize interaction between Districts. A priori
reasoning suggests that interaction increases as the road network
and the population density increase. Summarizing the above it seems
reasonable to conclude that the shape and size of the administrative
Districts, used by the Department of Highways, is influenced by both
the distribution pattern of the population, and the patterns of move-
ment.

Department of Transport

The Vehicle Inspection Branch was formed in 1957. And for the
purpose of administering this Branch of the Department of Transport,
the Province of Ontario was divided into ten administrative Districts.
These Districts consist of one or more counties depending on the
density of population and the amount of vehicle traffic. Each District
is administered from a central office, and the Department claims that
this office is located in the major municipality in the District. They
offer no evidence as to how the major municipality was determined.

The Districts were established for the purpose of serving the
various programmes of the Branch. The fundamental purpose of the
Branch is to administer and enforce all the Acts and Regulations per-
taining to the public transportation of goods and persons on the high-
ways of Ontario. This includes the issuing of licences, the inspection
of vehicles for mechanical fitness, checking weight and loading restric-
tions, inspecting school vehicles for safety and the inspection of
garages and vehicle wrecking establishments. All these have a bearing
on the general safety of the operation of vehicles on highways.

Ontario Provincial Police

The Ontario Provincial Police feel that to offer maximum police facilities to the population of Ontario, it is necessary to decentralize the organization and administration of police facilities. To achieve this aim the Province has been divided into seventeen Provincial Police Districts. Counties have been combined to form the Districts. The administrative centres have been located in centres which serve the Districts most "efficiently". The agency use this term to describe the choice of centres, but they do not offer a definition. It is assumed, by the writer, that the most efficient centre is the one which minimizes aggregate travel for the population within the District. Ideally this would place the centre at the centre of population gravity.

The O.P.P. claim that the size and shape of the Districts have been determined on the basis of, "geography", "population" and "judicial jurisdictions". However they do not offer precise definitions of these terms. The writer assumes that "geography" refers to the physical terrain and "population" means the distribution pattern. "Judicial jurisdictions" probably refers to the legal status of the county.

Summarizing, it appears that Counties have been combined to form administrative Districts, and the pattern of these Districts has been influenced by the distribution pattern of the population. The centres appear to have been located in the most accessible centre within each District, and the determination of accessibility has taken into account variations on travel time which have been produced by factors of the terrain.

Department of Public Welfare

The Province of Ontario has been divided into seventeen Field Service Branches to administer the General Welfare Assistance Act and its Regulations. Counties have been combined to form the administrative units.

Precise information, regarding the choice of criteria which were used to delimit the Branches, is not available. The general aims have been to equalize the work load among the administrative units, and to minimize the travelling time and distance between the population and the administrative centre within the unit. On the basis of these criteria, the shape, size and distribution of the Branches appears to have been influenced by the population distribution and the transportation network.

2.3 Summary

A summary of the findings of the qualitative study is presented below. The findings have been supplemented by a review of the literature in political science, economics, regional science, and geography; a visual examination of the agency's maps, and a priori reasoning. The following assumptions and hypotheses have been formulated:

1. Administrative areas and administrative centres are not located on a random basis. The delimitation of areas and the choice of centres are a product of a decision-making process.

2. The decision-making process appears to have been influenced by

   I   The regionalization schemes of other agencies.

   II The pattern of the population distribution.

   III The pattern of the movement of people through space.

3. The size and shape of administrative units appears to be arranged to equalize the work load among the units.

4. The objects to be administered by human service agencies are either the population en masse, or people as individual owners of certain material goods, for example, electrical appliances and automobiles.

5. The location of the administrative centre appears to have been selected as the largest urban centre which is nearest to the point of minimal aggregate travel for the population of the area. Centres are also located near main highways or at the junction of two or more routeways.

6. A simulation model of a political administrative system would need to incorporate some or all of the following variables:

    i   the distribution of the population.

    ii the mobility of the population in terms of time/cost/ numbers, as influenced by terrain, road conditions and time.

    iii the size and characteristics of towns suitable to be selected for administrative centres.

7. The size and characteristics of towns suitable to be selected for administrative centres should take into account some or all of the following:

    i   population and employment structure of the town and the area readily served by the town as an employment centre.

    ii number and types of functions.

    iii local university or research facilities.

    iv 'social' attributes of the town (including cultural facilities).

    v   accessibility to main routeways.

    vi availability of 'space'.

    vii the aim of the agency in its decentralizing policy.

Finally it is suggested that it is difficult to offer a precise definition of the relative importance of each agency. The expenditure and employment data tend to reflect annual fluctuations (though this in itself may not alter the ranking of the agencies). The variety in the nature of employment and the detailed expenditure patterns, for each agency militate against using this data for comparative analysis.

Agencies are equal with respect to their areal coverage and to the extent that they serve the demands of the total population.

2.4 Data for Quantitative Analysis

Following this qualitative analysis of the criteria used by the agencies in their selection of administrative areas and administrative centres, the next part of this chapter will consider a quantitative approach. An attempt will be made to offer an index of compactness for each administrative unit within each agency. The degree of comparability among the units, within and between agencies, will be determined. The analysis will examine the present arrangement of areas and centres. A development will be offered by defining the optimal location for the administrative centre, within the area currently used. Using a measure of the present arrangement, and a measure of an optimal arrangement, an index of efficiency, for each administrative unit, will be calculated.

Fundamental to the qualitative analysis is the assumption that, agencies attempt to define their administrative units in such a way as to make them as compact as possible. The measure of compactness will be defined later in this chapter. It is a measure of "central tendency" of an area. The concepts of central tendency and compactness are implicit in some political studies of city-regions, and administrative areas.

The aim of the next part of the study is to offer an explicit value for the compactness of all administrative areas used by the eight agencies in Southern Ontario. The findings of this analysis will be reported in the following chapter.

Comprehensive data for all the aspects of administrative areas and centres, discussed in the earlier parts of this chapter, are not available. The following data will be employed in the construction of the model, and in the testing of some of the hypotheses.

1. A six figure co-ordinate for the centre of all the townships in Southern Ontario. The co-ordinates were plotted using an analog plotter. There are 590 townships in the study area. The centre of each township was determined by eye.

2. The population of Southern Ontario was allocated to the nearest township. In the case of a town which is located on the boundary between two or more townships, the population of the town was divided equally among the adjacent townships.

3. The location of all the administrative centres have been placed at the centre of townships. In the case of a centre falling on the boundary between two or more townships, the centre was allocated to the township with the largest population.

4. The groups of townships which are used as administrative units by each agency.

In summary, all the population of Southern Ontario was allocated to townships, and each township and each administrative centre was given a six figure co-ordinate. The 590 townships were given catalogue numbers. Maps of the regionalization schemes, for all the agencies, were prepared, and groups of townships for each area were combined under their administrative centre. In the case of a township being divided between two administrative units, the township was allocated to the unit with the nearest administrative centre. The information was stored on I.B.M. data cards.

2.5   Construction of the Theoretical Model of a Political

Administrative Area

Quantitative techniques will now be used to combine the variables
and construct a model of a political administrative area.

When considering an areal distribution, it is necessary to
refine some of the statistical techniques which apply to a linear dis-
tribution. Weaver and Hess offer a refinement in their development of
a measure of areal compactness. They consider that:

> "Compactness is potentially a principle which, when combined
> with contiguity and equal population, could produce a non-
> discretionary districting procedure"[19]

A summary of the literature on methods for evaluating compactness
is offered by Chorley and Haggett.[20] Appendix C of this study, also gives
a brief review of some of the relevant literature on this subject.

The specific application by Weaver and Hess applies to a non-
partisan representative grouping procedure. And although the value
of using compactness as a guiding principle has frequently been suggested,
no precise definition of the term has been generally accepted. This
study will attempt to offer a definition of compactness which refers
specifically to the spatial arrangement of people within an administra-
tive unit.

A development of the "least squares" statistical technique will
be used.

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[19]J.B. Weaver and S.W. Hess, op. cit., p. 290.

[20]
   R.J. Chorley and P. Haggett, Frontiers in Geographical
Teaching, (London: Methuen, 1965), "Centrographic and Potential
Measures of Distribution", pp. 243-247.

The "least-squares" technique is suitable for the analysis of linear distributions, and is a measure of average location. The "least-squares" line on a graph is analogous to the centre of gravity in a physical body. The former has points arranged into a line, the latter has the weight of the body averaged into a central point. The example of the centre of gravity in a physical body approaches a concept immediately relevant to describing an areal distribution about a point. In studying the properties of rotating bodies physicists find it useful to have a measure of the dispersion of the body's weight about an axis of rotation. This measure is the moment of inertia (I).

$$I = \sum_{j=1}^{N} m_j \, d_j^2$$

I - moment of inertia

m - mass

d - distance from axis of rotation

N - number of particles

For bodies of equal weight, but differing distributions of weight, the moment of inertia for an axis running through the centre of gravity is smallest when the weight is concentrated at the centre, i.e. when the body is compact.

The moment of inertia can be used to provide a measure of compactness of the spatial arrangement of people with respect to the location of the administrative centre. The moment of inertia of a

body depends on the location of the axis of rotation, which is here defined as the location of the administrative centre, as well as on the shape of the body, here the shape of the administrative area. The value of the moment of inertia also depends on the manner in which the mass is distributed; for the analysis this is taken as the distribution pattern of the population.

Closely related to the concept of moment of inertia is the minimal aggregate travel concept. This also offers a measure of compactness using the same data as above. The aim here is to evaluate the effort required to move all points to a central location. The location of this point is optimal, that is the area is most compact, when the aggregate travel to this point is minimal. This is the centre of population gravity, and is at the same location as the axis of rotation for a body with minimal moment of inertia.

Reference to transportation costs was made in chapter one. If these costs are considered as a function of distance, then minimizing distance will have the same effect as minimizing transportation costs. Therefore a model which minimizes aggregate travel will be of the same form as a model which minimizes transportation costs.[21]

Moving from the discussion on the methods for quantitatively evaluating compactness, the next task is to describe the actual construction of the model.

The construction of the model is based on the principle of the moment of inertia, using the data discussed earlier in this

[21] Transportation costs are usually a non-linear function of distance. The above statement is only valid if transportation costs are a linear function of distance.

chapter. The calculation of the moment of inertia for each political administrative system will give a measure of compactness per se. Using the optimal location of the administrative centre, and calculating a new moment of inertia, an index of efficiency, for each unit, will be derived.

The moment of inertia for each area currently used is given the general term Ix. The moment of inertia for the optimal arrangement is termed Ig. By comparing Ix and Ig, that is by dividing Ig by Ix, the index of efficiency, E, is determined. The possible range of values is from 1 to 0. An index of 1 indicates that the location of the actual and the optimal centres are the same. It is postulated that the closer the value of this index is to 1, the more efficient is the political administrative unit. This assumes that maximum efficiency is to be found when the administrative centre is located at the point of minimal aggregate travel.

Tests for relationships between the indices, the number of administrative areas within each agency, and the distance between the actual and optimal locations, for the administrative centres, are discussed in the next chapter. The results of the tests of the model are also discussed in chapter three.

CHAPTER III

This chapter will attempt to apply the theoretical model of
a political administrative system developed in chapter two, to eight
human-service agencies for the case of Southern Ontario.

3.1 The Measure of Compactness

Using an I.B.M. 7040 computer the moments of inertia for all
areas and agencies have been calculated. The results are plotted on
Fig. 1. It is postulated that the lower the moment of inertia the more
compact is the area about the administrative centre. If all the moments
of inertia, within an administrative system, are summed, then it is
postulated that the lower this index for the agency, then the more com-
pact it is, i.e. the more efficient the arrangement of areas about local
centres. This method offers an objective analysis of the separation of
population and administrative centres.

From the results derived from this study it is evident that the
Ontario Hydro Commission has the highest total moment of inertia. This
agency also has the smallest number of regional subdivisions. The Ont-
ario Hospital Services Commission has the same number of administrative
units as the O.H.C. (5), yet the total moment of inertia (I_T) of the
system is lower by about one third. The I_T for the O.H.C. is 20.452^{10}
and the I_T for the O.H.S.C. is 14.158^{10}. The lowest total moment of
inertia is achieved by the regionalization scheme of the Department of
Public Welfare which uses twelve administrative areas.

Fig. 1 shows a ranking of agencies by comparing the total moment
of inertia for each one. Comparison within each agency, or between

MOMENT OF INERTIA
Eight Human—Service Agencies
Southern Ontario

Moment of Inertia
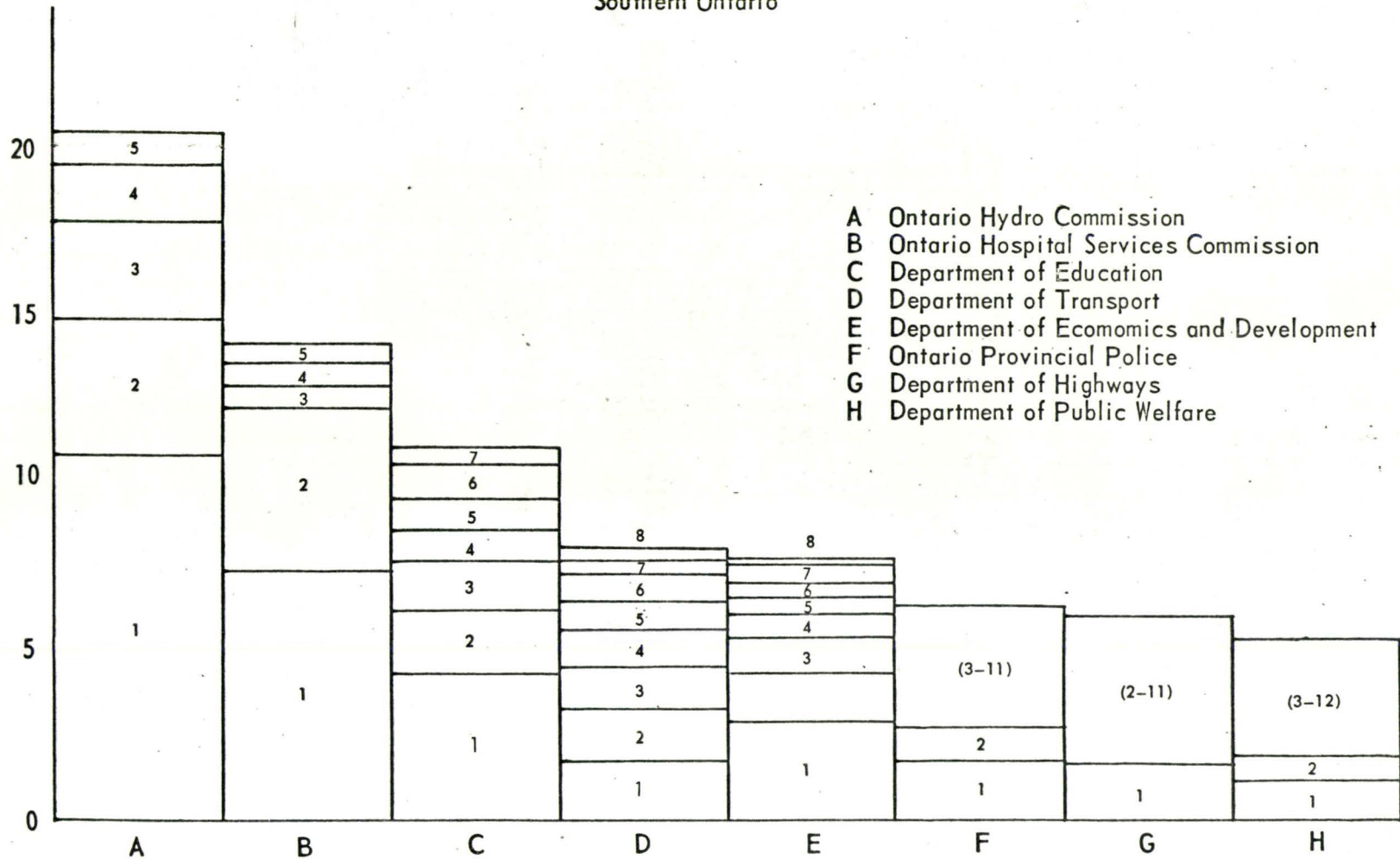
A   Ontario Hydro Commission
B   Ontario Hospital Services Commission
C   Department of Education
D   Department of Transport
E   Department of Ecomomics and Development
F   Ontario Provincial Police
G   Department of Highways
H   Department of Public Welfare

Fig. 1

smaller administrative units is made possible by examining the columnar divisions.

The columnar divisions indicate a value for the moment of inertia for each area. The numbers refer to the centres, and the letters refer to the agencies. Both are listed on pages 42, 43, 44 and 45.

For the three agencies, Ontario Provincial Police, Department of Highways and the Department of Welfare, not all the areas are shown. The values, for the moment of inertia, are less than .700 and such small values could not be clearly shown on a graph of the scale used here.

From an examination of the data (Table 1) and Fig. 1, it is evident that the administrative areas, within the agencies, vary in compactness. This is most pronounced in the case of the Ontario Hydro Commission, the Ontario Hospital Services Commission, and the Department of Education. For the other five agencies the administrative areas are relatively equal, with the general exception of the first administrative centre in each case. This is either Toronto or Downsview. The high value for Belleville (A 1), is explained by the eccentric location of the centre. It was selected by the Ontario Hydro Commission on grounds other than centrality. The availability of office space determined the choice. London — A 2, B 2, C 1, D 2, — also appears to have a relatively higher value than the other administrative areas for the four agencies, (Ontario Hydro Commission, Ontario Hospital Services Commission, Department of Education and Department of Transport). For the quantitative analysis, distance per se was used. If it had been possible to measure distance in terms of accessibility then London would probably have a lower value.

The following table 1 summarizes the results of the first part of quantitative analysis.

TABLE I

Moment of Inertia for all agencies[1]

A   Ontario Hydro Commission

1	Belleville	10.778
2	London	4.131
3	Toronto	2.820
4	Barrie	1.664
5	Hamilton	1.059
	TOTAL	20.452

B   Ontario Hospital Services Commission

1	Toronto	7.447
2	London	4.870
3	Ottawa	.817
4	Hamilton	.557
5	Kingston	.467
	TOTAL	14.158

C   Department of Education

1	London	4.411
2	Don Mills	2.095
3	Toronto	1.847
4	Kingston	.860
5	Ottawa	.848
6	Waterloo	.722
7	St. Catharines	.275
	TOTAL	11.058

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[1]The real value of the moment of inertia is $(Ix)^{10}$. For the purpose of comparative study the value Ix is used. The units for Ix are population x distance^2.

D	Department of Transport	
1	Ottawa	1.908
2	London	1.503
3	Toronto	1.190
4	Oshawa	1.154
5	Cooksville	.934
6	Chatham	.688
7	Hamilton	.392
8	St. Catharines	.276
	TOTAL	8.045

E	Department of Economics and Development	
1	Toronto	2.904
2	Ottawa	1.492
3	Midland	1.223
4	Chatham	.688
5	Peterborough	.547
6	Grimsby	.384
7	Aylmer	.328
8	Stratford	.239
	TOTAL	7.805

F   Ontario Provincial Police

1	Downsview	1.720
2	Mount Forest	1.013
3	Long Sault	.672
4	London	.660
5	Perth	.566
6	Chatham	.514
7	Barrie	.392
8	Burlington	.373
9	Belleville	.241
10	Peterborough	.110
	TOTAL	6.339

G   Department of Highways

1	Downsview	1.729
2	Owen Sound	.691
3	Chatham	.688
4	Burlington	.658
5	London	.542
6	Ottawa	.477
7	Stratford	.314
8	Kingston	.287
9	Port Hope	.279
10	Parry Sound	.190
11	Bancroft	.148
	TOTAL	6.003

H	Department of Public Welfare	
1	Toronto	1.190
2	Kitchener	.751
3	Chatham	.688
4	Ottawa	.483
5	Hamilton	.477
6	Barrie	.439
7	London	.344
8	Kingston	.295
9	Lindsay	.263
10	Wingham	.174
11	Belleville	.141
12	Alexandria	.072
	TOTAL	5.317

H	Department of Public Welfare	
1	Toronto	1.190
2	Kitchener	.751
3	Chatham	.688
4	Ottawa	.483
5	Hamilton	.477
6	Barrie	.439
7	London	.344
8	Kingston	.295
9	Lindsay	.263
10	Wingham	.174
11	Belleville	.141
12	Alexandria	.072
	TOTAL	5.317

3.2   Relationship between Moment of Inertia and Number of Administrative Areas

An examination of the relationship between the moment of inertia and the number of administrative areas used by the agency follows.

Table 2 shows the agency and its number of regions, also the total moment of inertia, the logarithm and the square-root of the moment of inertia. An attempt will be made to derive an empirical linear relationship between a function of 'moment of inertia' and 'number of regions'.

Scatter diagrams for the following are plotted on figs. 2, 3, and 4.

I	Moment of inertia	Number of regions
II	Square-root of the moment of inertia	Number of regions
III	Logarithm of the moment of inertia	Number of regions

Least squares lines have been calculated and fitted to the scatter diagrams.

Results of the correlation analysis are shown below.

$$\text{I} \qquad r = -.8743 \qquad r^2 = 76.43\%$$

$$\text{II} \qquad r = -.9115 \qquad r^2 = 83.07\%$$

$$\text{III} \qquad r = -.9433 \qquad r^2 = 88.98\%$$

The values of r^2 indicate the percentage of variation in one variable which is explained by changes in the second variable.

From the data used in this study there appears to be a linear relationship between, 'a function of the moment of inertia' and 'the number of regions used by an agency'. The closest linear relationship was provided by correlating 'Log I_T' and 'number of administrative units'. 88.98% of the variation is explained by this relationship.

The results support the hypothesis that as the number of administrative regions used by an agency increases, the value of the total moment

Scatter Diagram of the Moment of Inertia (I) and Number of Regions (N)

$r = -.874$
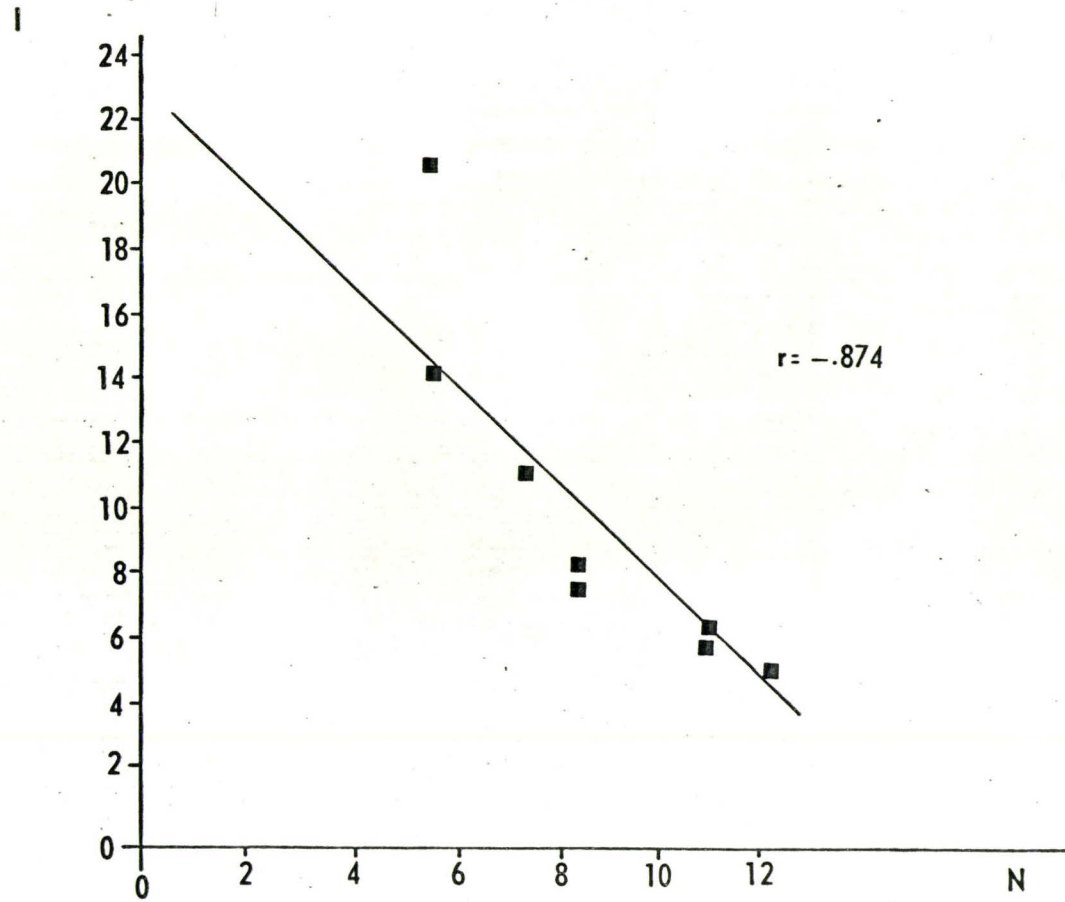
Fig. 2

Scatter Diagram of the Square Root of the Moment of Inertia($\sqrt{I}$) and Number of Regions (N)

$r = -.911$
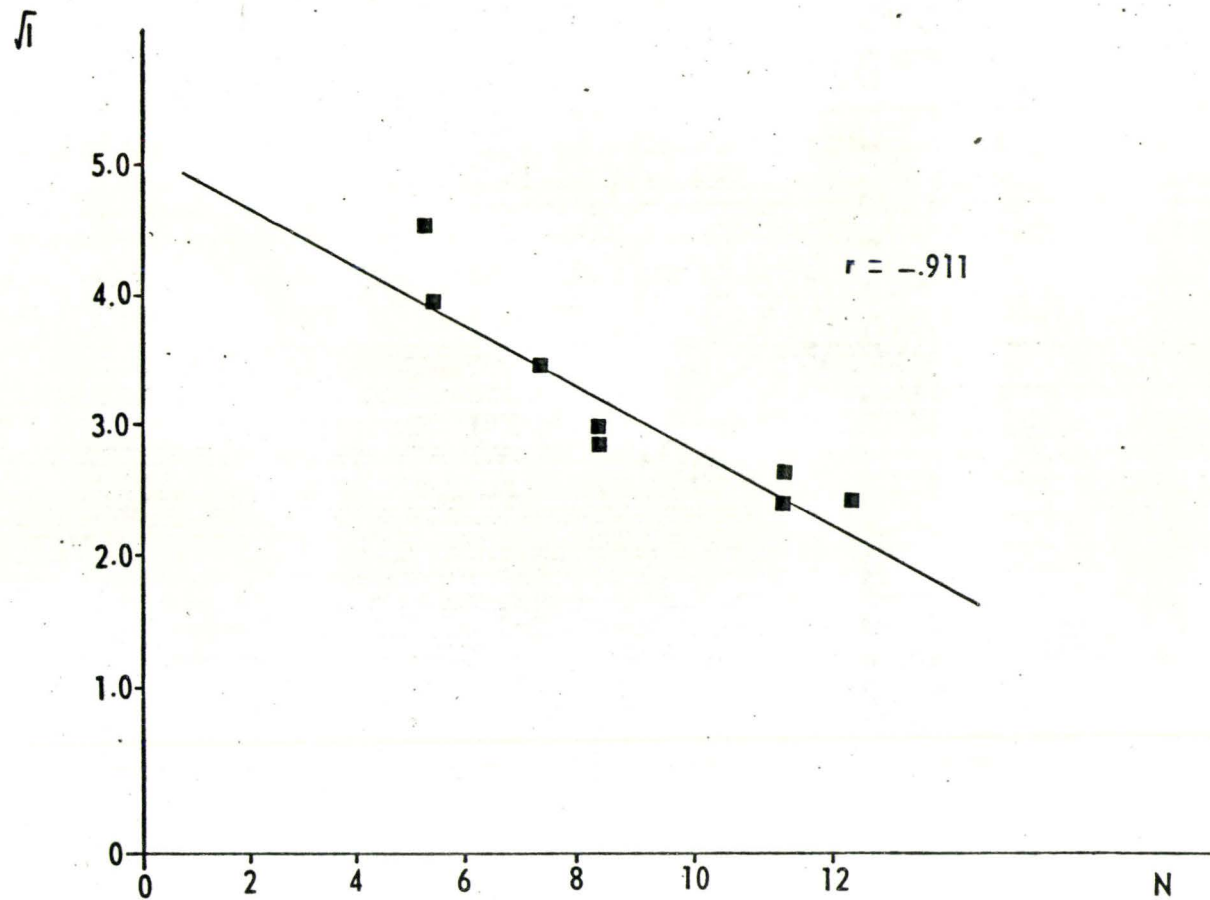
Fig. 3

Scatter Diagram of the Logarithm of the Moment of Inertia (Log I) and Number of Regions (N)

$r = -.943$
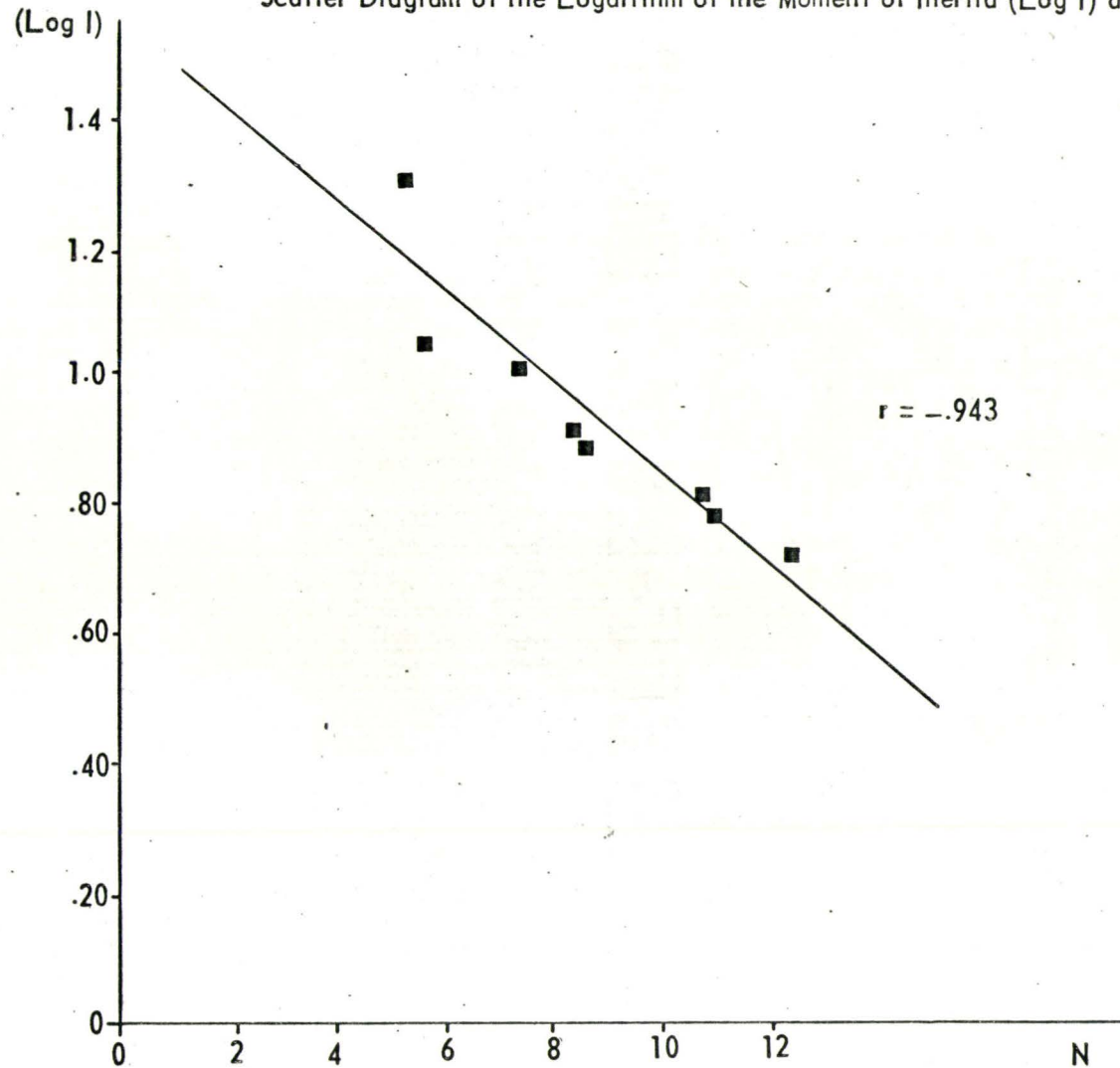
Fig. 4

TABLE 2

Data for Scatter Diagrams

Agency	Moment of Inertia (Total) I_T^2	Log. I_T	I_T	Number of Regions
Department of Economics and Development	7.80	0.8921	2.79	8
Department of Education	11.06	1.0437	3.32	7
Department of Highways	6.00	0.7782	2.45	11
Ontario Hydro Commission	20.45	1.3107	4.52	5
Ontario Hospital Services Commission	14.16	1.1501	3.76	5
Ontario Provincial Police	6.34	0.8021	2.52	11
Department of Public Welfare	5.36	0.7292	2.32	12
Department of Transport	8.05	0.9058	2.84	8

[2]Total moment of inertia of the system; this is the sum of the moments of inertia of the administrative areas about the centres currently used.

of inertia of the system decreases. The high correlation (r= -.943)
between the logarithm of the total moment of inertia and the number
of regions indicates that the relationship between the total moment of
inertia of the system, and the number of regions is asymptotic.

3.3   Optimal Arrangement of Administrative Centres

This section will offer new locations for administrative centres
within the administrative areas currently used. The results of this
research are presented cartographically (Figs. 5 through 12). The act-
ual and optimal locations for all centres are plotted.

It must be stressed that optimality has an explicit definition
in this work. It is taken to mean, the point in space which is at the
centre of population gravity for a particular distribution of people.
Implicit in this definition is the assumption that the number of people
at a specific location influences the location of the optimal point.
This point is located at the position of minimal aggregate travel.

This study has not attempted to locate the new administrative
centres in actual towns. The points calculated to provide the lowest
moment of inertia for the area are marked on the maps as the optimal
locations for the administrative centres.

A discussion of the spatial arrangements of the eight agencies
follows.

The maps that have been prepared for this analysis, indicate
the administrative areas used by each agency in Southern Ontario. With-
in each area, the administrative centre currently used and the optimal
location for the centre are noted. The main highways used by the popula-
tion of Southern Ontario are the 401, 400, 7, 6 and the Queen Elizabeth

Way.[3] These highways have been marked on the following maps. Other
highways, on which some of the centres are located, are referred to in
the text.

Department of Economics and Development

The actual administrative centres compare very closely with the
optimal ones. The largest displacement is 15 miles in the case of
Aylmer (E = .686).[4] London would provide a more central location for
an administrative centre, and the advantages of a large city with a
university, research facilities and available employees, as well as
location near the 401, should be considered. A study of administrative
areas was made by Aitken in 1966,[5] and he noted that Aylmer was selected
as a centre "because it was not a large town and it was hoped that the
department could work more easily from here." He reported that, "the
local municipalities felt overshadowed by the large city of London.
However the Department of Economics and Development have decided to re-
locate the centre at London, because it offered more services." This
move has not, as yet, been made. The initial choice of Aylmer illus-
trates that factors, other than those readily conceived, (such as cen-
trality, or size of town) may influence the choice of centre.

---

[3]Department of Highways, A Plan for Ontario Highways, Toronto
1956, pp. 23-25.

[4]E is the index of efficiency. It is obtained from the formula
$E = \frac{Ig}{Ix}$, where Ig is the moment of inertia about the optimal centre, and
Ix is the moment of inertia about the actual centre.

[5]R. Aiken, "A Geographical Study of the Administrative Boundaries
and Centres of Selected Ontario Agencies", Unpublished paper, Department
of Geography, McMaster University, Hamilton, 1966.

GEORGIAN BAY

LAKE
HURON

LAKE   *ONTARIO*

Ottawa

Midland

7

400

401

Peterborough

6

Toronto

Q.E.W.

Stratford

7

Grimsby

DEPARTMENT OF ECONOMICS AND DEVELOPMENT

401

Aylmer

ECONOMIC REGIONS

APRIL 1967

Chatham

LAKE

ERIE

ADMINISTRATIVE CENTRES

○ Actual Location

■ Optimal Location

10 0 10 20 30

Scale in Miles
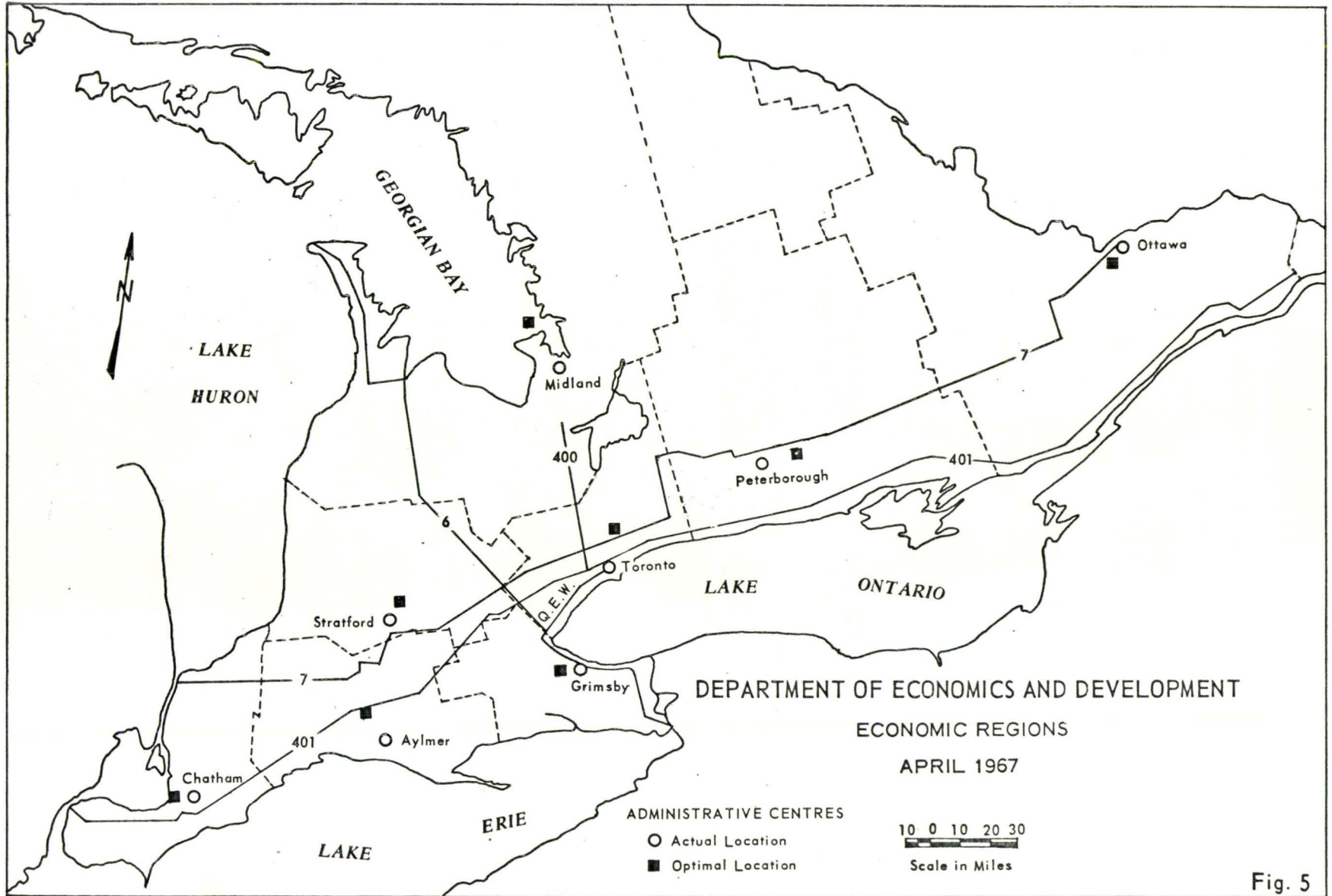
Fig. 5

Toronto has a relatively low index (E = .692). In the quantitative analysis the population of Metropolitan Toronto was divided among six townships, and because of the large numbers of population a high value for the moment of inertia was derived. This produces a low index of efficiency.[6]

Department of Education

The administrative centres of the Department of Education tend to lie on or near the main east-west highways of Southern Ontario. The centre at London, with an index of efficiency of .587, has the largest linear displacement; a more centrally located centre would appear to be at Chatham. This would fit the constraint of access to a main highway, here the 401. However Chatham does not have a university; an important criteria in the choice of centres for this agency.

Toronto (E = .692) and Don Mills (E = .502) lie nearer the main routeways than the optimal centres.

Even though St. Catharines has the high index of efficiency of .930 this index could possibly be improved by relocating the centre at Hamilton. Like St. Catharines, Hamilton has a university and access to a main highway.

Kingston (E = .669) lies about thirty-five miles east of the optimal location. Belleville offers a possible location, though it does not have a university and is smaller in population than Kingston. It may not offer the socio-economic standards required by employees in this agency.

---

[6]In the equation $E = \frac{Ig}{Ix}$, as Ix increases E decreases

LAKE HURON

GEORGIAN BAY

N

6

Waterloo

Don Mills

Toronto

Q.E.W.

St. Catharines

London

7

401

LAKE ERIE

LAKE ONTARIO

Ottawa

Kingston

401

7

DEPARTMENT OF EDUCATION

EDUCATIONAL AREAS

NOVEMBER 1966

ADMINISTRATIVE CENTRES

○ Actual Location

■ Optimal Location

10 0 10 20 30
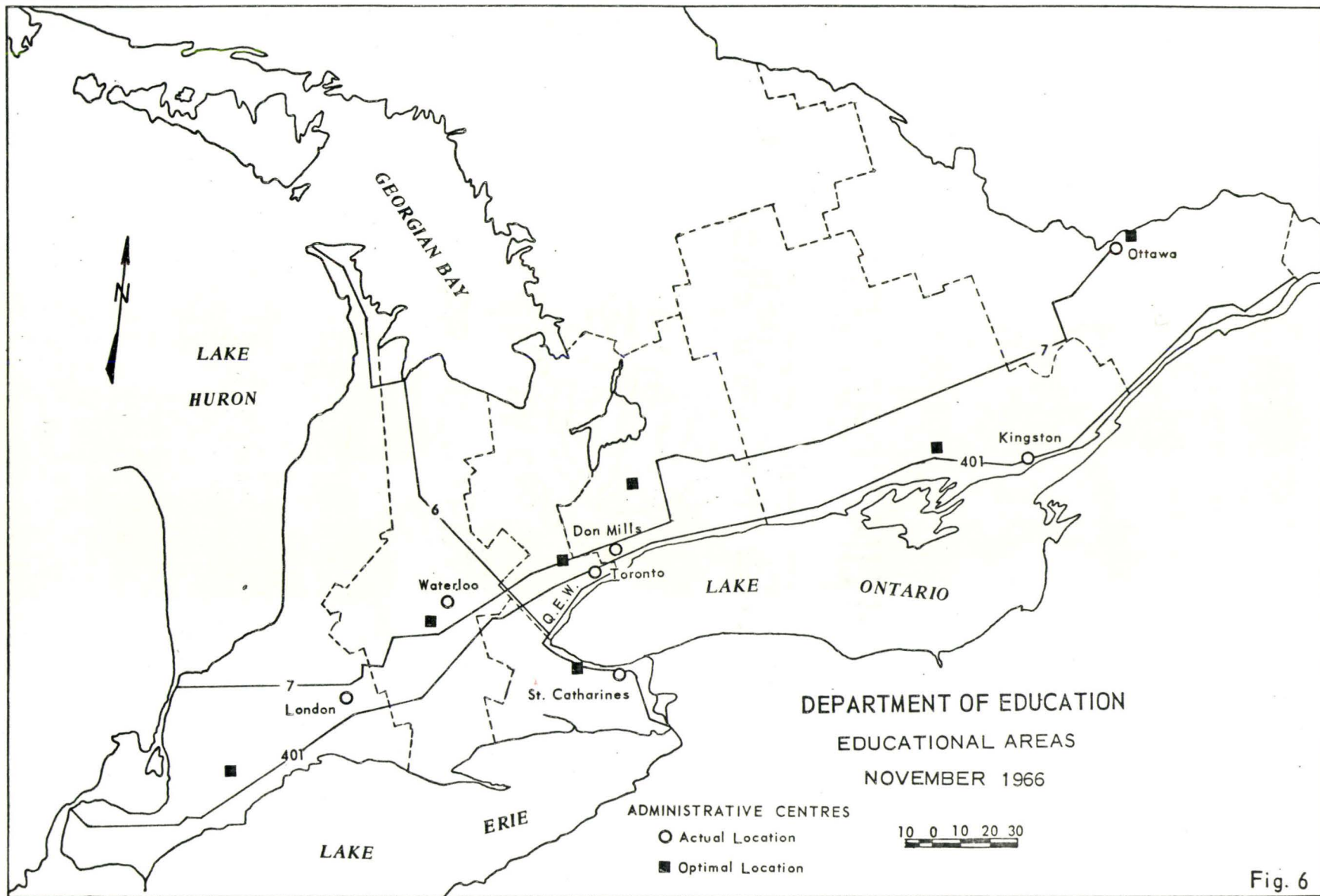
Fig. 6

In general, considering the areas currently used, the administrative centres are at the most satisfactory locations from the standpoint of minimal aggregate travel, access to main highways and university facilities.

Department of Highways

With the third lowest value for the total moment of inertia (6.0^{10}) the regionalization plans for this agency appear to be among the most satisfactory.

Centres at Chatham (E = .735), London (E = .635), Burlington (E = .884) and Kingston (E = .905) lie near the main east-west highways of Southern Ontario; the 401 and the Queen Elizabeth Way.

Stratford (E = .764) has the advantage of being a route centre at the junction of highways 19, 8 and 7. However the centre could be relocated at Waterloo, thus maintaining road accessibility, and offering faster access to the 401. The advantages of locating in a large town, such as a labour force, may be offset by the higher cost of office space. But a move to Waterloo would improve the centrality aspect of the centre's location.

Owen Sound (E = .461) has a low index of efficiency; the lowest for this agency. This town is the largest in the northwestern part of Southern Ontario. A move to Mount Forest would probably improve the location of the centre vis-à-vis the distribution of population. Mount Forest is used by the O.P.P., which suggests that office staff is available. Whether two administrative centres could be supported would only be revealed by a closer study. However a case for combining facilities could be made, and in the future agencies with similar interests may work more closely, in terms of office facilities and other services.

GEORGIAN BAY

LAKE
HURON

LAKE ERIE

LAKE ONTARIO

N

Parry Sound

Ottawa

Bancroft

Owen Sound

6

400

401

Kingston

Port Hope

Downsview

Stratford

Burlington

7

London

401

Chatham

DEPARTMENT OF HIGHWAYS

ADMINISTRATIVE DISTRICTS

NOVEMBER 1966

ADMINISTRATIVE CENTRES

○ Actual Location

■ Optimal Location

10 0 10 20 30

Scale in Miles
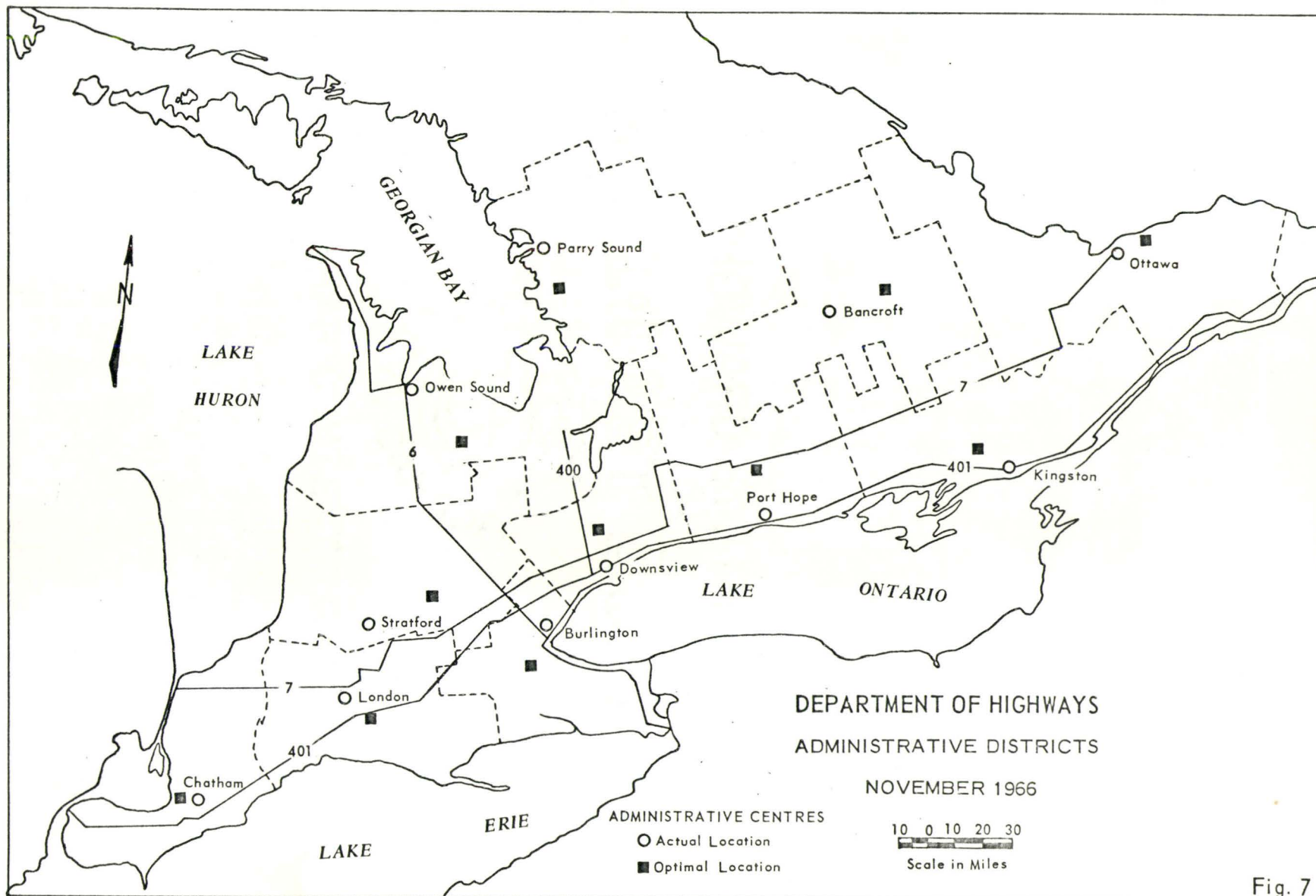
Fig. 7

Though Bancroft has a low index of efficiency, (E = .496) it is accessible by road to most parts of the administrative region. Situated at the junction of highways 500, 62 and 28 it is at the best location in an area which has relatively few nodal points of a suitable size. The optimal point falls in the Madawaska Valley.

Parry Sound, though eccentrically located within the administrative area, is only about 20 miles from the optimal location. The small towns in the rest of this area are all smaller than Parry Sound. Parry Sound is situated at the junction of highways 124, 518 and the main north-south road in this part of Southern Ontario, highway 69.

Ontario Hydro Commission

The location of the administrative centres has remained unchanged through time, though industrial expansion and population growth have radically altered the spatial demand for power in Southern Ontario. From the 1900's when the Ontario Hydro Act was passed, and during the recent years when the number of regions has decreased to the present five in Southern Ontario, the administrative centres have been maintained.

Hamilton is the most satisfactorily situated with an index of efficiency of .988, Belleville has the low index of .447. Ottawa would be a more suitable location for the latter centre. The choice of Belleville rested on the available office space already owned by the Ontario Hydro when regionalization plans were being implemented. The choice of Toronto (E = .701) as an administrative centre could not be radically improved. However it would be possible to improve the index of efficiency of the administrative centre which serves the southwestern part of Southern Ontario. Currently London is used, the writer recommends a move to Chatham. Though Chatham has approximately one fifth of the population

HYDRO–ELECTRIC POWER COMMISSION OF ONTARIO

REGIONAL ORGANIZATION

DECEMBER 1966

ADMINISTRATIVE CENTRES

○ Actual Location

■ Optimal Location

10 0 10 20 30

Scale in Miles

Fig. 8

LAKE HURON

GEORGIAN BAY

Barrie

400

Belleville

401

6

Toronto

LAKE

ONTARIO

Q.E.W.

Hamilton

7

London

7

401

LAKE

ERIE

LAKE HURON

GEORGIAN BAY

400

401

Ottawa

Kingston

6

7

Q.E.W.

Toronto

Hamilton

London

401

LAKE ONTARIO

LAKE ERIE

ONTARIO HOSPITAL SERVICES COMMISSION

REFERRAL REGIONS

APRIL 1967

ADMINISTRATIVE CENTRES

○ Actual Location

■ Optimal Location

10 0 10 20 30

Scale in Miles

Fig.9

of London, access to a main highway, 401, would be maintained.

The centre at Barrie (E = .659) serves a large area which extends both east and west of Georgian Bay. Access to these two areas is most satisfactorily provided by maintaining the present centre. A move towards the optimal centre, which is located near Parry Sound, would improve the index of efficiency.[8]

To improve the arrangement of areas around administrative centres the writer suggests that centres be selected, and the administrative areas be redefined to equalize and minimize the moment of inertia among the areas.

Ontario Hospitals Services Commission

Both Ottawa (E = .962) and Kingston (E = .889) lie very close to the optimal locations for centres of hospital referral regions. The actual centre at Toronto (E = .728) is approximately 30 miles south of the optimal location, however the advantages offered in a large city, such as laboratory services and university medical facilities, outweigh a travel factor as low as this.

No suitable urban unit corresponds to the optimal location for the Hamilton area. Hamilton (E = .852) is presently used. The prospect of the increase in medical research facilities at McMaster University obviously exerts a strong force in the strengthening of the administrative functions of this centre.

London (E = .870) is the most advantageously located administrative centre for the area it serves.

---

[8] For the quantitative analysis distances across Georgian Bay have been considered as the shortest air-line distance. Therefore for this administrative area, the index of efficiency is not an accurate measure of the spatial distribution of population vis-à-vis access to the administrative centre.

The present location of administrative centres cannot be radically improved, in terms of locating near the centre of population gravity. All the centres used by this agency have high values for the index of efficiency.

Ontario Provincial Police

With eleven administrative centres in Southern Ontario the indices of efficiency vary from Peterborough ($E = .992$) to Chatham ($E = .302$).

All the centres for this agency appear to satisfy one or more of the following conditions:

1. They are located on main highways. (See Fig. 10)

2. They are located on or near sections of the highway with a heavy traffic flow, for example at Burlington.

3. They are located near large towns, for example Downsview and London.

4. They are located near frontier stations, for example Long Sault and Niagara Falls.

5. They are centrally located within the administrative area they serve, for example Perth.

In view of the variety of conditions which appear to influence the choice of administrative centres, the following recommendations are made with respect to only two criteria. Firstly, access to a main highway and secondly, an attempt is made to improve the index of efficiency. Recommendations are as follows:

1. The centre at Chatham be moved to Tilbury, this town lies on the highway 401, and would offer a more central location than either Chatham or Windsor.

2. The centre at Mount Forest ($E = .617$) be moved to Waterloo. Though this would remove the centre from the main north-south highway in the western part of Southern Ontario (6), access would be maintained to highways 7 and 401.

GEORGIAN BAY

LAKE HURON

LAKE ONTARIO

LAKE ERIE

Long Sault

Perth

Barrie

400

Belleville

401

Peterborough

Mount Forest

6

7

Downsview

Q.E.W.

Burlington

Niagara Falls

London

7

401

Chatham

N

ONTARIO PROVINCIAL POLICE

POLICE DISTRICTS

NOVEMBER 1966

ADMINISTRATIVE CENTRES

○ Actual Location

■ Optimal Location

10 0 10 20 30

Scale in Miles
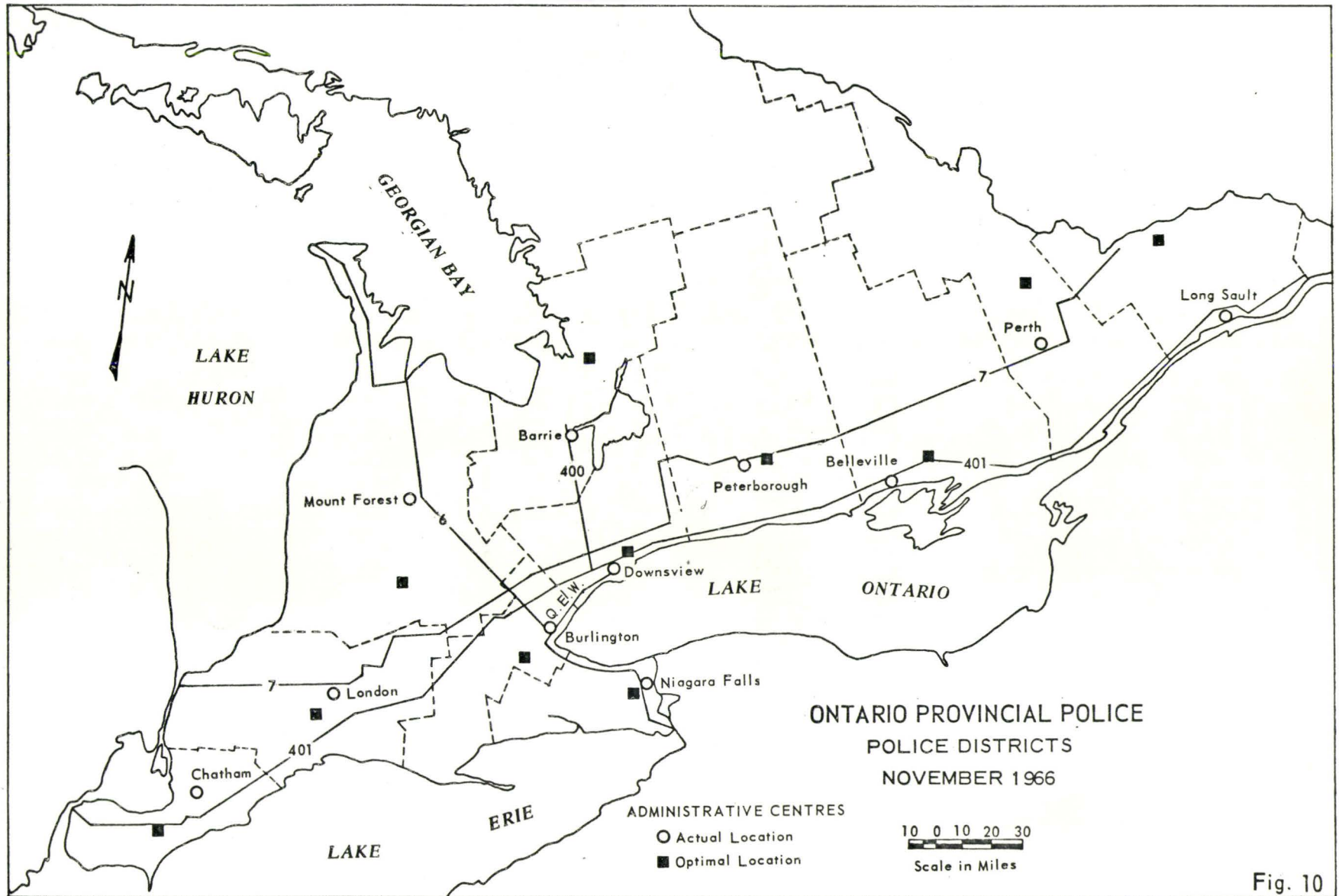
Fig. 10

3. The centre at Barrie (E = .754) could be relocated at Midland. However this would remove the administrative centre from the main highway junction in this part of Ontario, and mobility may be hampered during the winter months if the centre was placed on relatively minor routeways (highways 27 and 12 at Midland).

Finally, though Perth is over twenty miles south of the optimal location, the high index of efficiency (E = .933) suggests that the location is satisfactory.

Department of Public Welfare

With the principle of accessibility to centres by the population being foremost in the minds of the regional planners a high index of efficiency, for all centres, is to be expected. Of the twelve administrative centres used by this agency, five have values for the index of efficiency which are above the mean for all the agencies (.754). Ottawa has the highest index .937, and the lowest is Barrie with a value of .504. The mean value for the Department of Public Welfare is .717.

Location on or near main highways (e.g. 400, 401, or Q.E.W.) serves to reduce the effective distance between population and centres. The low mean moment of inertia for the Department of Welfare is .445^{10} and the total moment of inertia of the system is 5.36^{10}; these values are the lowest of all the agencies examined. The implication is that the areas are compact and the present spatial arrangement of centres and areas serve the population very well.

Only slight improvements are possible, as the centres have to be located in fairly large urban areas which offer access to main highways.

LAKE HURON

GEORGIAN BAY

Alexandria

Ottawa

Barrie

400

Lindsay

Kingston

401

Wingham

Kitchener

Toronto

LAKE   ONTARIO

Hamilton

6

7

London

401

Chatham

ERIE

LAKE

DEPARTMENT OF PUBLIC WELFARE

FIELD SERVICE BRANCH

NOVEMBER 1966

ADMINISTRATIVE CENTRES

○ Actual Location

■ Optimal Location

10 0 10 20 30

Scale in Miles
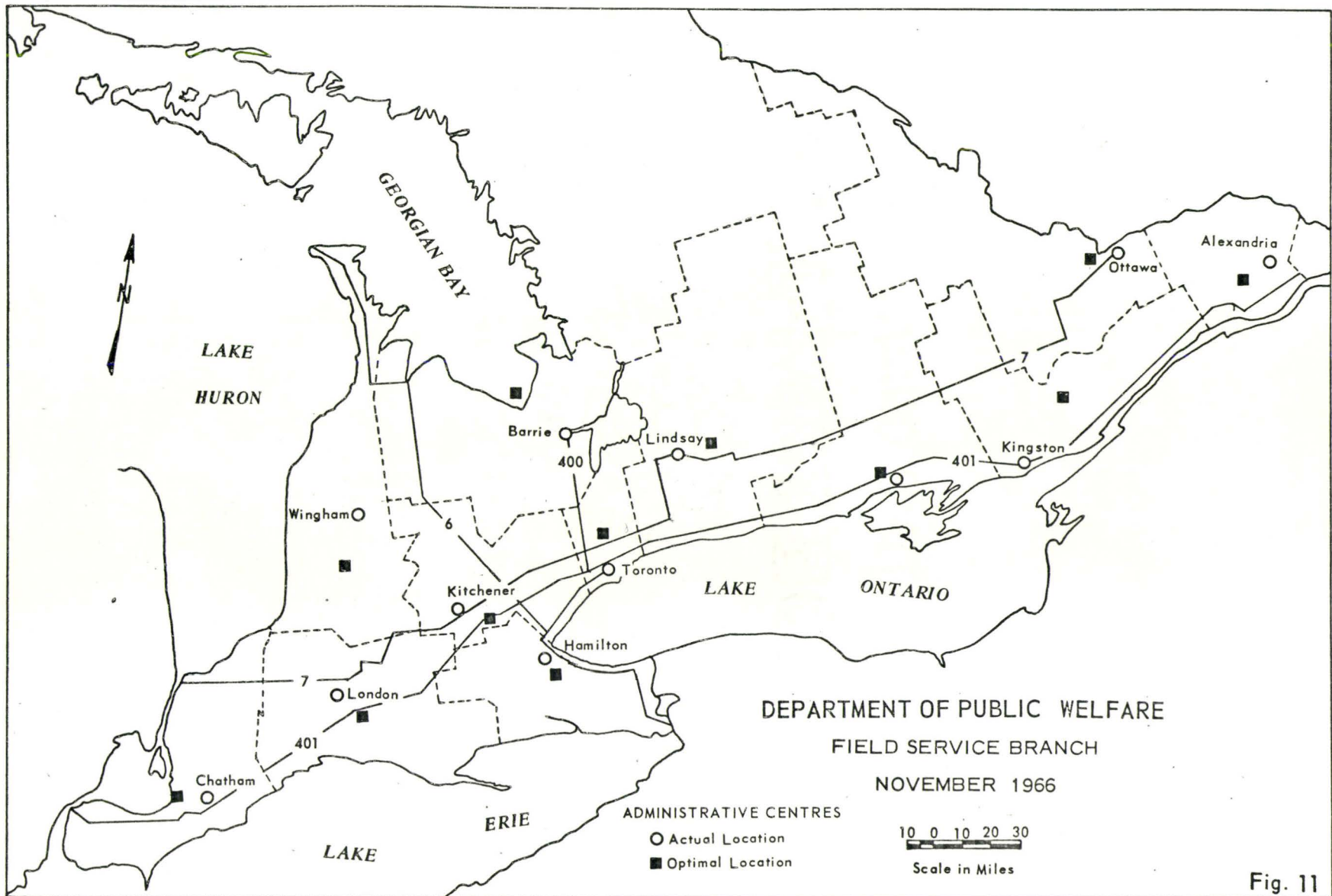
Fig. 11

Department of Transport

The branch of this department chosen for analysis is the Vehicle Inspection Branch. Formed in 1957 this Branch has increased the number of regions it uses, but it has maintained the system of using county boundaries.

Centres at Chatham (E = .735), London (E = .839), Hamilton (E = .855) St. Catharines (E = .981), Cooksville (E = .499), Toronto (E = .784) and Oshawa (E = .570) are located on the main transit lines of Southern Ontario (401 and Q.E. W.). (See Fig. 12).

The optimal locations generally show a displacement to the north and away from these routeways. It would be impracticable to move the centres away from the main access routes. The centre located at London serves the largest area in Southwestern Southern Ontario. The area extends from the Bruce Peninsula to the shores of Lake Erie. The optimal location for the centre for this area is about 25 miles north-east of London. This places the new centre near Stratford. Access to highways 7, 8, and 19 is available from Stratford. However with approximately one eighth of London's population, it is unlikely that the centre will be moved to Stratford.

Oshawa is about 35 miles south-west of the optimal location and a new centre could be at Peterborough on highway 7. Eccentrically located, Cooksville has the lowest index of efficiency.

3.4   The Index of Efficiency

By relocating the administrative centre, within the area currently used, it is possible to calculate a new moment of inertia for the system. When the new centre is at the centre of population gravity, the moment

GEORGIAN BAY

LAKE
HURON

Ottawa

400

6

Oshawa

7

401

Toronto

Q.E.W.

Cooksville

LAKE ONTARIO

Hamilton

St. Catharines

7

London

N

401

Chatham

LAKE ERIE

DEPARTMENT OF TRANSPORT

VEHICLE INSPECTION BRANCH

DECEMBER 1966

ADMINISTRATIVE CENTRES

○ Actual Location

■ Optimal Location

10 0 10 20 30

Scale in Miles
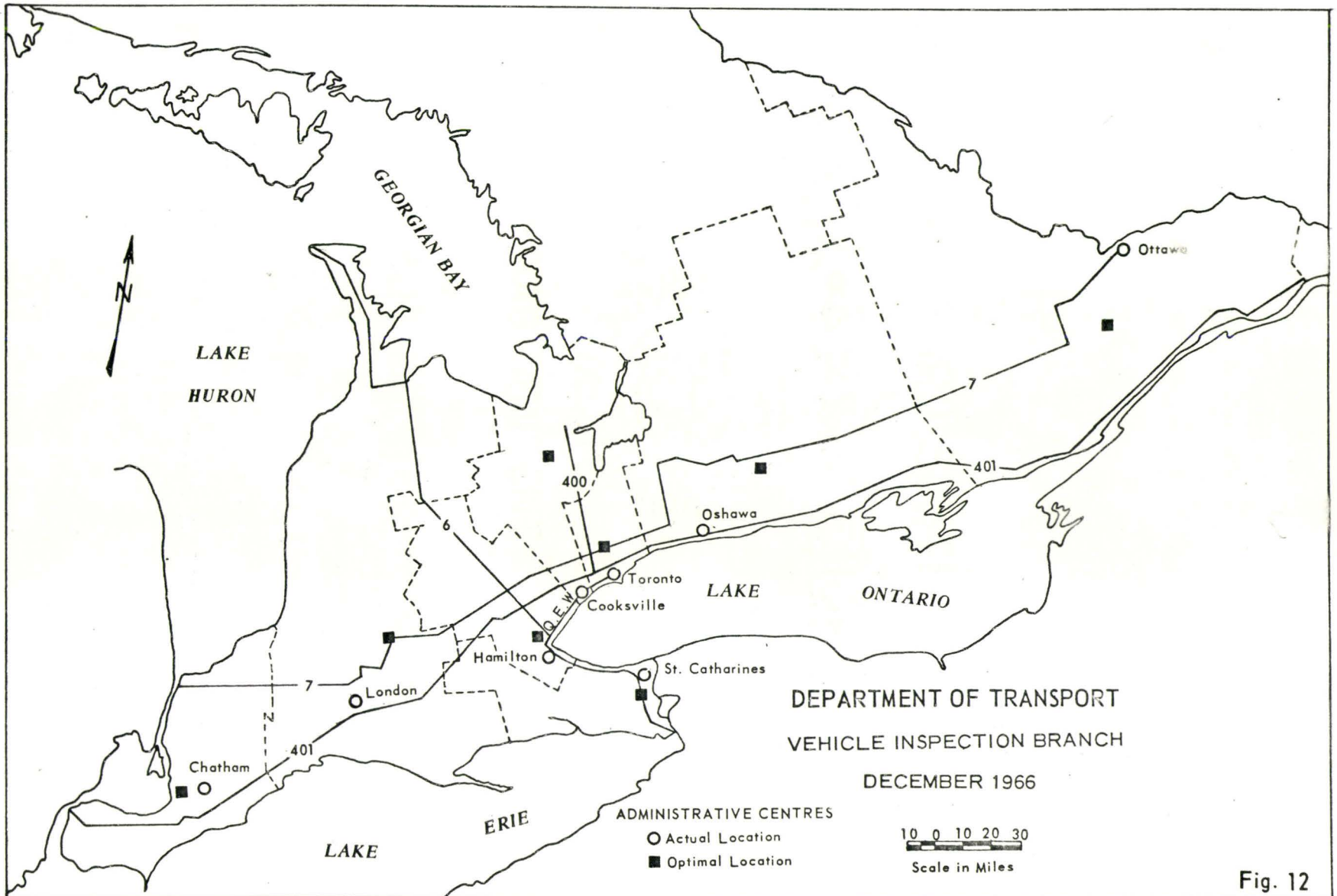
Fig. 12

of inertia is minimum. The index of efficiency is derived by comparing the moment of inertia about the actual centre, with the moment of inertia about the optimal centre.

$$E = \frac{Ig}{Ix}$$

E = Index of efficiency

Ig = Moment of inertia about optimal location of administrative centre

Ix = Moment of inertia about actual centre

Indices of efficiency for each administrative region and a mean value for each agency, are shown on Table 3.

It is postulated that this index is a measure of the degree to which the present location of the administrative centre relates to the optimal location (this being at the centre of population gravity).

By correlating E (index of efficiency) with the distance, in miles, separating the actual and optimal centres, it is possible to test the hypothesis that, 'E is a function of linear distance separating the actual optimal centres.' The results of the correlation analysis are shown below.

	r	r^2
1. Department of Economics and Development	-.913	82%
2. Department of Education	-.772	59%
3. Department of Highways	-.638	39%
4. Ontario Hydro Commission	-.784	60%
5. Ontario Hospital Services Commission	-.956	90%
6. Ontario Provincial Police	-.679	44%
7. Department of Public Welfare	-.605	36%
8. Department of Transport	-.734	53%

TABLE 3

Indices of Efficiency

Department of Economics and Development

Aylmer	.686
Chatham	.735
Grimsby	.971
Midland	.757
Ottawa	.958
Peterborough	.765
Stratford	.801
Toronto	.692
MEAN	.796

Department of Education

Don Mills	.502
Kingston	.669
London	.587
Ottawa	.973
St. Catharines	.930
Toronto	.692
Waterloo	.966
MEAN	.760

Department of Highways

Bancroft	.496
Chatham	.735
Burlington	.905
Downsview	.769
Kingston	.905
London	.635
Ottawa	.808
Owen Sound	.461
Parry Sound	.544
Port Hope	.884
Stratford	.764
MEAN	.791

Ontario Hydro Commission

Barrie	.659
Belleville	.447
Hamilton	.988
London	.560
Toronto	.700
MEAN	.679

Ontario Hospital Services Commission

Hamilton	.852
Kingston	.889
London	.868
Ottawa	.963
Toronto	.728
MEAN	.860

Ontario Provincial Police

Barrie	.753
Belleville	.738
Burlington	.871
Chatham	.302
Downsview	.898
Long Sault	.320
London	.834
Mount Forest	.617
Niagara Falls	.796
Peterborough	.992
Perth	.933
MEAN	.732

Department of Public Welfare

Alexandria	.597
Barrie	.504
Belleville	.921
Chatham	.735
Hamilton	.781
Kitchener	.541
Kingston	.536
Lindsay	.729
London	.655
Ottawa	.937
Toronto	.784
Wingham	.887
MEAN	.717

Department of Transport

Chatham	.735
Cooksville	.499
Hamilton	.855
London	.839
Oshawa	.570
Ottawa	.947
St. Catharines	.981
Toronto	.784
MEAN	.776

Mean Indices of Efficiency for Agencies

Department of Economics and Development	.796
Department of Education	.760
Department of Highways	.719
Ontario Hydro Commission	.679
Ontario Hospital Services Commission	.860
Ontario Provincial Police	.732
Department of Public Welfare	.717
Department of Transport	.776
MEAN	.754

E is a measure of the ratio of two spatial distributions (from two centres within the distribution). The actual amount of explanation of variation in E accounted for by variation in distance is shown in the r^2 column of the above table. The negative sign in front of the coefficient of correlation (r) indicates that as E increases (i.e. approaches 1) the distance between the actual and optimal centres decreases.

The distance variable does not explain all variations in E; Probably some elements of the distribution pattern of the population, within the administrative area, could be included for a more complete explanation of the variation in E. For example a homogeneous distribution would allow 'distance' to explain a higher percentage of the variation in E than if the settlement pattern is strongly divergent from homogeneity.[9]

The correlation coefficients vary from -.605 to -.956, indicating that within the group of eight agencies there is variation of the power of the distance variable to explain variations in E. However for the purposes of this study the index of efficiency is accepted as a dimensionless spatial measurement of the relative location of the administrative centre, vis-à-vis the optimal location.

3.5   Ranking of Agencies

This section is concerned with offering two systems for ranking the spatial arrangement of administrative areas used by the eight agencies.

The first method uses the mean index of efficiency which was cal-

---

[9]This could be tested by detailed analysis of each area of each agency.

RANKING OF AGENCIES
Index of Efficiency

A Ontario Hospital Services Commission
B Department of Ecomomics and Development
C Department of Transport
D Department of Education
E Ontario Provincial Police
F Department of Highways
G Department of Public Welfare
H Ontario Hydro Commission

Index of Efficiency

A   B   C   D   E   F   G   H
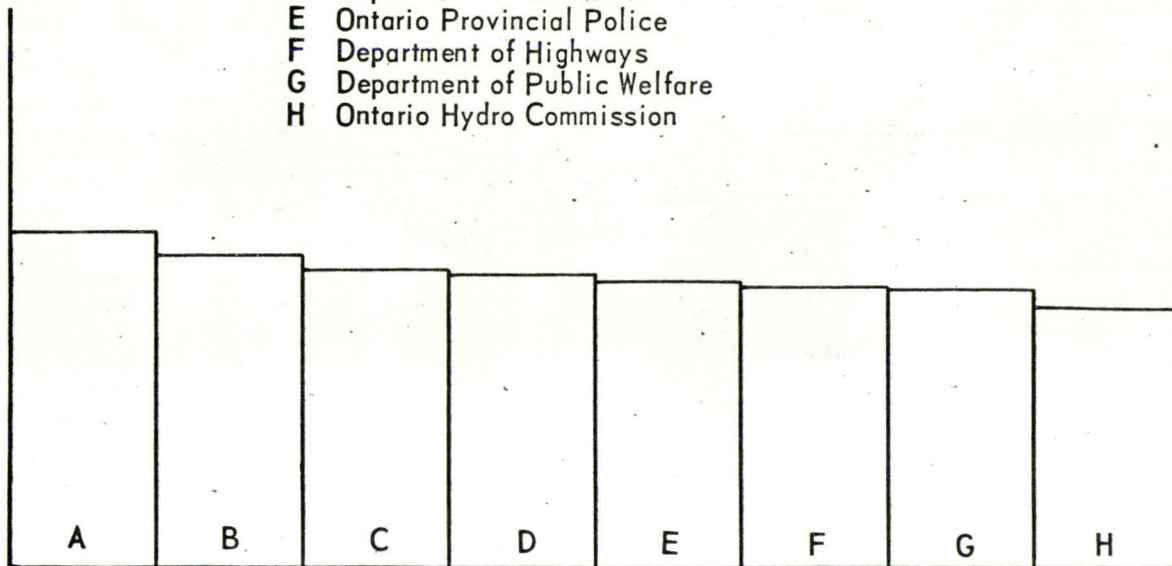
Fig. 13

RANKING OF AGENCIES

Logarithm Moment of Inertia (log I_T)

A Department of Transport
B Department of Public Welfare
C Ontario Provincial Police
D Department of Education
E Ontario Hydro Commission
F Department of Ecomomics and Development
G Department of Highways
H Ontario Hospital Services Commission

Log I_T

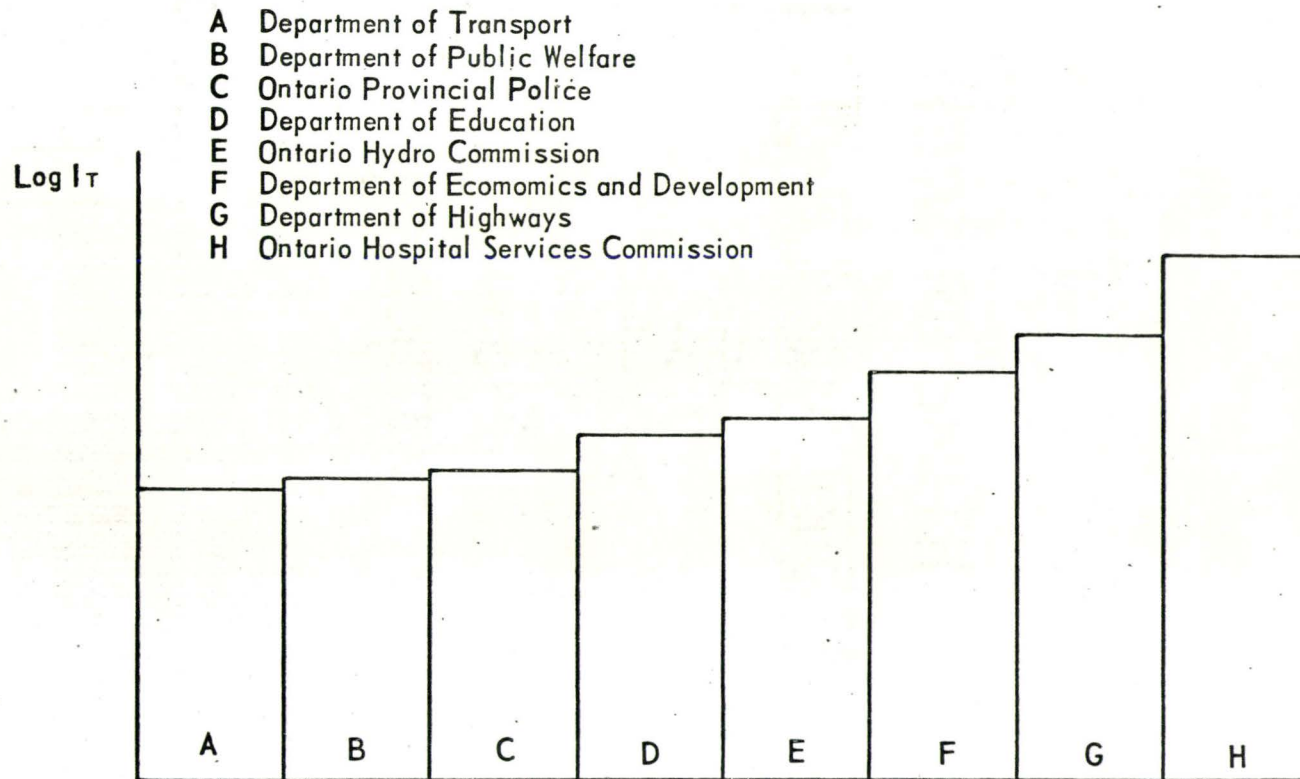A   B   C   D   E   F   G   H

Fig. 14

culated in the earlier part of this study. The second method combines

the number of administrative areas and the moment of inertia for each

agency into a single ranking.

Agencies vary with respect to the number of administrative areas

they use and also the value for the moment of inertia. The high correla-

tion between the logarithm of the total moment of inertia of each system,

and the number of administrative areas used $(r = .943)$, allows a single

ranking of the logarithm of the moment of inertia to incorporate almost

90% of the variation in the number of areas used by the agencies.

The following Table 4 summarizes the data which are used to con-

struct the ranking graphs. The ranking graphs are Fig.13 and Fig. 14.

The ranking systems exhibit considerable variations. Only the

Department of Education maintains the same position on both scales. The

greatest shift in position is offered by the Ontario Hospital Services

Commission. This agency appears to be the least compact yet has the

highest mean index of efficiency.

Considering the two ranking systems; the first, (Fig.13) uses the

index of efficiency which is a dimensionless number referring to an actual

and a theoretical location of an administrative centre within an area.

Hence the ranking in this case is an abstract measure of a spatial pattern.

The second system uses the logarithm of the total moment of inertia and

is a measure of the compactness of the present arrangement. This refers

to the separation of population and administrative centres. By using the

logarithm, variations in the number of administrative areas used by the

agencies are incorporated into a single ranking scale.

The mean index of efficiency for all agencies is .754 and hence

the following agencies, Department of Economics and Development, Depart-

ment of Education, Ontario Hospital Services Commission, Department of Transport, can be considered as being more efficient than the mean.

The mean value for Log. I_T[10] for all agencies is .9514. It is postulated that the lower the value of Log I_T the more compact is the arrangement of administrative areas. The following agencies, Department of Education, Ontario Hydro Commission, Ontario Provincial Police, Department of Public Welfare and the Department of Transport, all have values for Log I_T which are less than the mean for all agencies. It can be concluded that these agencies have the most compact spatial arrangements. By comparing both ranking scales it appears that two agencies, the Department of Education and the Department of Transport have the most satisfactory spatial arrangements for their administrative areas.

3.6   Test of Centrality of Administrative Centres

This test refers specifically to the first hypothesis on page 32 in chapter two. The first part of the hypothesis states that, administrative areas and administrative centres are not located on a random basis. This section will attempt to design and apply a statistical test of this hypothesis. The index of efficiency, for each administrative region, will be used.

The sixty-seven indices of efficiency for the eight agencies have values that fall within the range of 1 to 0. A value of 1 indicates perfect correlation between the actual and the optimal location of the administrative centre. A value of 0 indicates maximum inefficiency, that is the optimal centre is located at infinity.

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[10]For a definition of I_T see footnote 2.

TABLE 4

Data for Ranking Agencies

Agency	Log I_T [11]	E [12]
Department of Economics and Development	1.0437	.796
Department of Education	0.8921	.760
Department of Highways	1.1501	.719
Ontario Hydro Commission	0.9058	.679
Ontario Hospital Services Commission	1.3107	.860
Ontario Provincial Police	0.8021	.732
Department of Public Welfare	0.7782	.717
Department of Transport	0.7292	.776
MEAN VALUES	.9514	.754

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[11]For a definition of I_T see footnote 2.

[12]This is the mean value of the indices of efficiency for the administrative areas used by the agency.

It is postulated that if these sixty-seven values are part of a normal distribution, then the array of values must conform to a pattern. Variations from this pattern will indicate a 'greater than' or 'less than' normal distribution. For a normal distribution, the ratio of data between standard deviations is as follows:

Mean to one standard deviation	17
One standard deviation to two standard deviations	7
Two standard deviations to three standard deviation	1

The ratio is 17:7:1 and for sixty-seven readings this is 45:19:3. The diagram below indicates the form of a normal distribution.

Mean
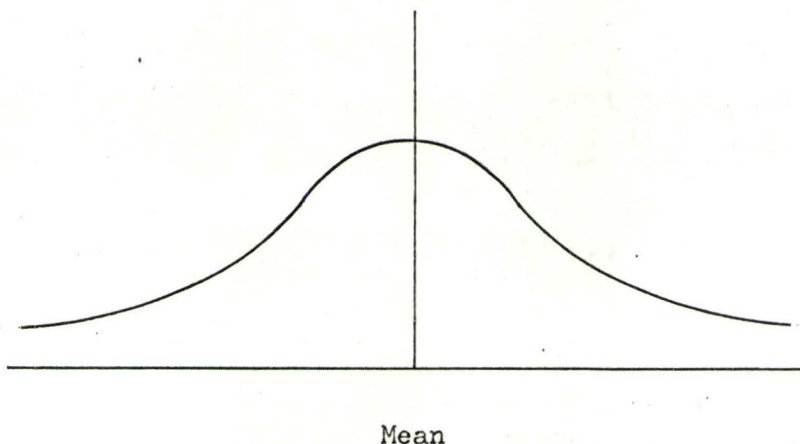
For the purpose of this analysis it is assumed that, the sixty-seven readings are the positive readings of the distribution. There is no rationale for assigning negative values to the indices of efficiency. To do this it would be necessary to arbitrarily indicate that displacement of the optimal centre from the actual centre is positive or negative. This study assumes that all displacements are positive. If a complete distribution had been used, the values would fall between 0 on the negative side of the y axis to 0 on the positive side of the y axis. If the

values are normally distributed the mean value would be 1.

For the purpose of the statistical analysis of the positive part of the distribution the mean of the distribution was taken as 1. Variations from the mean were calculated by finding the difference between the index of efficiency and the mean. The standard deviation was calculated to be .302. Substracting this from the mean gives a value of .698 for the index of efficiency which is one standard deviation from the mean. Two standard deviations give the value .396 for the index of efficiency, and three standard deviations .094.

The observed ratio for the 67 readings is 44:21:2. This compares very closely with the calculated ratio (indicative of a normal distribution) of 45:19:3. From this analysis it appears that the distribution (i.e. the location of administrative centres) approximates very closely to a normal distribution. The statistical inference that can be drawn from this fact is that, the actual centres tend to cluster around the optimal centres. This supports the hypothesis that the actual centres are not located on a random basis, but tend to be located near the centre of population gravity (the point of minimal aggregate travel) of the administrative area. This finding supports the evidence provided by interviews and questionnaires that, centres tend to be located with reference to the population distribution.

3.7 Summary

This chapter has provided a quantitative analysis of the spatial

arrangement of the eight agencies, with specific reference to the location of the administrative centre, and the distribution pattern of the population. Reference has been made to a 'measure of compactness' and an 'index of efficiency'. The optimal location of centres was discussed, with reference to the administrative areas currently used.

A general comment for the choice of administrative centres in Southern Ontario is that, improvements in their location are possible, though in some cases these would only involve a move of a few miles. The costs of such a move may be greater than the savings produced by relocating the administrative centre.

CHAPTER IV

4.1 Central Place Theory and Administrative Areas and Centres.

The spatial distribution of urban places has been intensively and extensively studied in Central Place research. Centres have been classified according to their size,[1] the number and type of functions found within each centre,[2] and also with respect to the distance from a centre of a similar size. From this work it has been suggested that a hierarchy of centres can be recognized. The emphasis in this type of work is on the understanding of consumer behavior, and hence the centres are considered as market places offering goods and services to people located around the central places. The administrative centres examined in this study offer services to the population within the administrative unit surrounding the centre.

The fundamental postulate of Central Place Theory is that man behaves rationally in his use of space. This implies that man attempts to maximize benefits and minimize the costs of organizing space. Work on "space preferences"[3] gives some insight into personal motivations and goal gratification, and lays emphasis on the decision-making process. This process is complex, yet the patterns produced may be finite and readily observed, for example, the location of centres in administrative areas.

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[1] E.N. Thomas, "Towards an Expanded Central-Place Model", The Geographical Review, Vol. LI, No. 3, July 1961, pp. 400-411.

[2] J.L. Berry and W.L. Garrison, "The Functional Bases of the Central Place Hierarchy", Economic Geography, Vol. 34, 1958, pp. 145-154.

[3] D.L. Huff, "A Topographical Model of Consumer Space Preferences", Papers and Proceedings of the Regional Science Association, Vol. VI, 1960, pp. 159-173.

This study has attempted to recognize some of the factors which may have been considered by the decision makers when the administrative areas were delimited and the centres located. No attempt has been made to order the sequence of variables in the decision-making process. The present research notes that there are a variety of centres that have been selected to serve as administrative centres. Specific analysis of the composition of the centres in terms of attributes and variates[4] has not been undertaken in this work. The research has concentrated on a study of the location of the centres within administrative areas with respect to the distribution of the population in the same area. The population size of each centre has also been considered. This chapter offers an analysis of the relative importance of administrative centres in Southern Ontario.

4.2   Classification of Administrative Centres

Specifically this chapter will be concerned with the development of a classification scheme of the administrative centres used by eight human service agencies in Southern Ontario. The classification will be based on the frequency of use of each centre by the eight agencies, the population size of the centre, and the moment of inertia for the areas served by the centre. A measure of importance for each centre will be derived. All centres are considered to be de jure equal. However this may not be realistic and future work could be concerned with devising a weighting for each centre. The weighting for the centre could incorporate the following:

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[4]B.J.L. Berry and W.L. Garrison, op. cit.

1. The amount of office space either in terms of area or rent.

2. The number of employees in terms of salary.

It has not been found possible to incorporate such a weighting system into the present analysis.

For the administration of the eight agencies thirty-two centres are used. It is postulated that if one agency has four administrative centres and another has eight, the former centres will be more important than the latter, and also the most important centres will be utilised first by an agency. The term "important" needs definition. In the initial attempts by the agencies to divide Southern Ontario into areas around centres, a centre could be defined as "important" if its position and size, vis-à-vis other centres was higher than any other centre within the defined area.

For the purpose of this analysis it is considered that if a centre is used by all agencies it will have a percentage frequency of 100. The following diagrams illustrate the theory of the classification system. The aim is to be able to compare the frequency of use of centres among the agencies when the agencies have different numbers of administrative centres.

4.3   Model of Classification System

<table>
<thead>
<tr><th></th><th></th><th>Value assigned
to each centre</th><th></th></tr>
</thead>
<tbody>
<tr><td>Agency 1</td><td>A. | B.</td><td>A</td><td>.5</td></tr>
<tr><td></td><td></td><td>B</td><td>.5</td></tr>
<tr><td>Agency 2</td><td>A. | B.
C. | D.</td><td>A</td><td>.25</td></tr>
<tr><td></td><td></td><td>B</td><td>.25</td></tr>
<tr><td></td><td></td><td>C</td><td>.25</td></tr>
<tr><td></td><td></td><td>D</td><td>.25</td></tr>
<tr><td>Agency 3</td><td>A. | B.
C. | D.
E. | F.</td><td>A</td><td>.166</td></tr>
<tr><td></td><td></td><td>B</td><td>.166</td></tr>
<tr><td></td><td></td><td>C</td><td>.166</td></tr>
<tr><td></td><td></td><td>D</td><td>.166</td></tr>
<tr><td></td><td></td><td>E</td><td>.166</td></tr>
<tr><td></td><td></td><td>F</td><td>.166</td></tr>
</tbody>
</table>

TABLE 5

Data for Model of Classification System

Centre	Frequency of use	Sum of the values assigned to the centre	Percentage frequency of total use[6]
A	3	.916[5]	100%
B	3	.916	100%
C	2	.416[5]	45.41%[7]
D	2	.416	45.41%
E	1	.166	18.12%
F	1	.166	18.12%

---

[5]For centre A, .916 = .5 + .25 + .166.
For centre C, .416 = .25 + .166

[6]The percentage frequency column is considered to indicate the relative importance of the administrative centres. It has been derived from the adjacent column.

[7]For centre C, $45.41\% = \dfrac{.416}{.916} \times 100$

4.4 Application of the Model to the Administrative Centres of Southern Ontario.

The table 6 shows the centres used by the agencies in Southern Ontario. The results of this analysis are presented graphically on Fig. 15 and Fig. 16 . Fig. 15 shows the frequency of use of centres. All the centres can be accommodated in seven groups. However, Fig. 16 which shows the percentage frequency of total use, provides fourteen groups, and hence a more detailed analysis of the relative importance of centres is provided by the second graph.

An initial ranking of the importance of centres is provided by Fig. 15. This graph indicates that London is the most frequently used centre. Ottawa and Toronto are used six times, and Chatham five times. The two centres, Hamilton and Kingston, are used four times and Barrie and Belleville three times. The following centres are used twice, Burlington, Downsview, Peterborough, St. Catharines and Stratford. Finally there are nineteen centres that are used only once. A priori reasoning suggests that these vary in importance. Fig. 16 provides a more detailed division of the use of centres on the basis of the percentage frequency of total use. In this case Toronto is more frequently used than London, and Hamilton is more frequently used than Chatham. Both Stratford and Peterborough have the same percentage frequency use and are lower than St. Catharines by 4.92%. On Fig. 15 these three centres appear to be equal.

On Fig. 16 the centres which are only used once are divided into four groups. The following table 7 indicates the percentage frequency of total use of centres which are used only once by the agencies.

TABLE 6

Administrative Centres in Southern Ontario

Centre	Frequency of use	Sum of the values assigned to the centre[8]	Percentage Frequency of total use
Alexandria	1	.083	7.84
Aylmer	1	.125	11.81
Bancroft	1	.091	8.60
Barrie	3	.374	35.34
Belleville	3	.374	35.34
Burlington	2	.182	17.20
Chatham	5	.515	48.68
Cooksville	1	.125	11.81
Don Mills	1	.143	13.51
Downsview	2	.182	17.20
Grimsby	1	.125	11.81
Hamilton	4	.608	57.45
Kingston	4	.417	39.41
Kitchener	1	.083	7.84
Lindsay	1	.083	7.84
London	7	.933	88.18
Long Sault	1	.091	8.60
Midland	1	.125	11.81
Mount Forest	1	.091	8.60
Niagara Falls	1	.091	8.60
Oshawa	1	.125	11.81

Centre	Frequency of use	Sum of the values assigned to the centre	Percentage Frequency of total use
Ottawa	6	.767	72.49
Owen Sound	1	.091	8.60
Parry Sound	1	.091	8.60
Perth	1	.091	8.60
Peterborough	2	.216	20.41
Port Hope	1	.091	8.60
St. Catharines	2	.268	25.33
Stratford	2	.216	20.41
Toronto	6	.967	91.39
Waterloo	1	.091	8.60
Wingham	1	.083	7.84

---

[8]If a centre is used by all agencies it will have a total value of

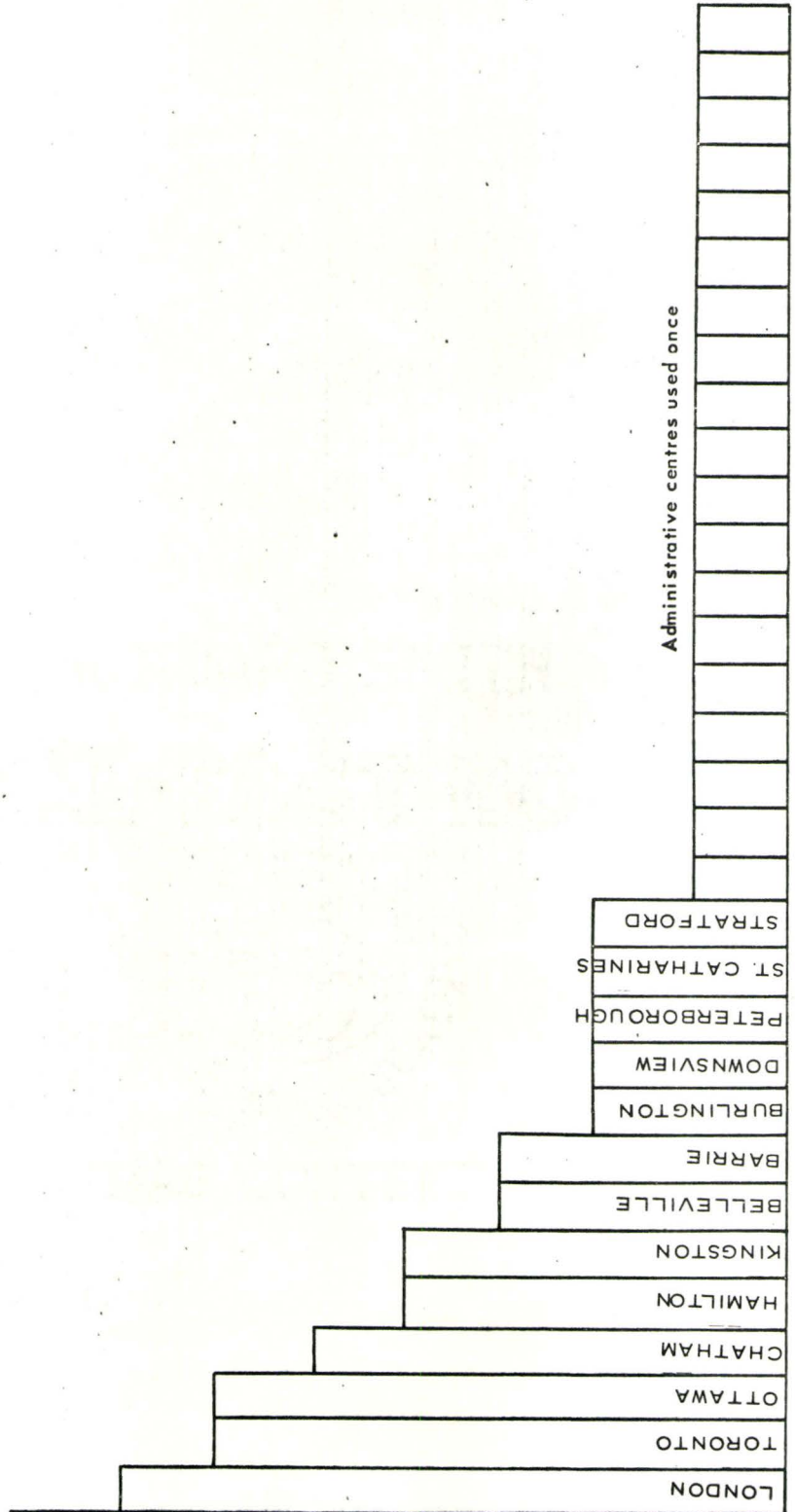$$\frac{1}{5} + \frac{1}{5} + \frac{1}{7} + \frac{1}{8} + \frac{1}{8} + \frac{1}{11} + \frac{1}{11} + \frac{1}{12} = 1.058$$

The denominator indicates the number of administrative areas used by an agency

FREQUENCY OF USE OF CENTRES

Frequency of Use

Administrative Centres

Administrative centres used once

Fig. 15

PERCENTAGE FREQUENCY OF TOTAL USE OF CENTRES

Administrative centres used once

Administrative Centres
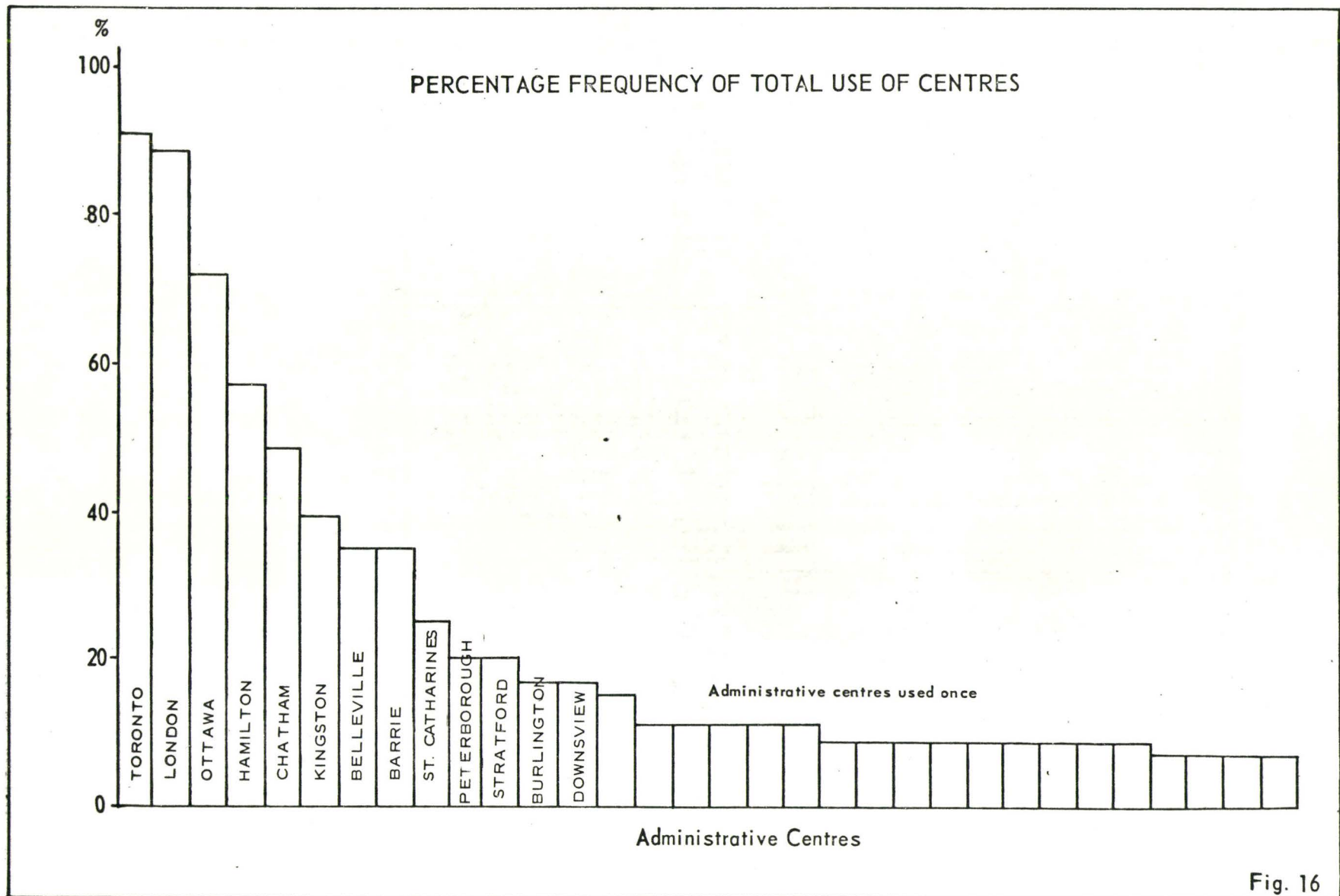
Fig. 16

TABLE 7

Percentage Frequency of Total Use of Administrative

Centres used once

13.51%	Don Mills
11.81%	Aylmer
	Cooksville
	Grimsby
	Midland
	Oshawa
8.60%	Bancroft
	Long Sault
	Mount Forest
	Niagara Falls
	Owen Sound
	Parry Sound
	Perth
	Port Hope
	Waterloo
7.84%	Alexandria
	Kitchener
	Lindsay
	Wingham

Table 8 shows a ranking of centres that are used more than once. In this case centres are ranked by population size, the moment of inertia of the areas they serve, the frequency of use, and the percentage frequency of total use. It is postulated that the centres with the largest population size will be used most frequently, and also that the centres with the highest moment of inertia will be used most frequently.

From this analysis it appears that though all administrative centres enjoy de jure equality, de facto importance varies.

TABLE 8

Administrative Centres used more than once

Frequency of use	Population	Percentage Frequency of use[9]	Moment of Inertia
London	Metropolitan Toronto[10]	Toronto	London
Ottawa)	Hamilton	London	Toronto
)			
Toronto)	Ottawa	Ottawa	Belleville
Chatham	London	Hamilton	Ottawa
Hamilton)	St. Catharines	Chatham	Chatham
)			
Kingston)	Kingston	Kingston	Downsview[11]
Barrie)	Peterborough	Barrie)	Barrie
)		)	
Belleville)	Burlington	Belleville)	Hamilton
Burlington[12]	Chatham	St. Catharines	Kingston
Downsview	Belleville	Stratford	Burlington
Peterborough	Barrie	Peterborough	Peterborough
St. Catharines	Stratford	Burlington)	Stratford
		)	
Stratford		Downsview)	St. Catharines

[9]In the case of the Department of Education, Don Mills and Toronto are used as separate administrative centres. For the purpose of the quantitative study the two centres have been treated individually. Don Mills is part of Metropolitan Toronto. This does not affect the ranking according to percentage frequency of use. However it does influence the ranking of the frequency of use of centres. If Don Mills had been treated with Toronto then the frequency of use of Toronto would have increased to 7, and this would have placed it equal to London.

[10]Metropolitan Toronto includes Downsview, therefore only twelve centres are listed in this column. There are thirteen in the other columns.

[11]If Downsview was included with Toronto, then Toronto would head the list.

[12]If Burlington was included with Hamilton, then in column one Hamilton would have the same frequency of use as Ottawa and Toronto, in Column two there would be no change in the relative position of Hamilton, in column three Hamilton would be the third centre, and in column four Hamilton would be the sixth centre.

4.5 Conclusions

In summary this chapter has attempted to devise a method for grouping and ranking all the administrative centres used by eight human-service agencies in Southern Ontario. For centres which are used only once, the percentage frequency of total use analysis indicates that they can be divided into four groups. Don Mills appears to be the most important centre which is used only once. However Don Mills can be classed with Toronto, therefore it is more realistic to note that the following five centres, with a percentage frequency value of 11.81%, are the most important centres which are only used once.

    i   Aylmer

    ii   Cooksville

    iii Grimsby

    iv   Midland

    v   Oshawa

The findings of this research are summarized on Table 7.

The following four indicators have been used to rank centres which are used more than once; the frequency of use, the percentage frequency of total use, the population of the centre, and the moment of inertia of the administrative areas served by the centre. The rankings are presented in Table 8.

Considering the whole of Southern Ontario, it appears that Toronto is the most important administrative centre, and London and Ottawa are only slightly less important. Chatham ranks fairly high in all columns except population. Its importance is probably due more to its location then to the number or variety of services it can provide. Hamilton has

the second highest population score, yet only appears to be approximately as important as Chatham. Kingston could be ranked with Hamilton and Chatham in importance, however it appears to serve its areas more efficiently as it has a lower moment of inertia score than either Chatham or Hamilton. Barrie's location makes it a fairly important centre. Barrie has the second lowest population score. Belleville's eccentric location within its administrative area for the Ontario Hydro Commission, gives it a high score for the moment of inertia.

The least important centres for the administration of human-service agencies appear to be, Stratford, Peterborough, St. Catharines and Burlington, as well as the centres which are only used once. These centres are listed in Table 7.

Three centres in Southern Ontario with large populations are Windsor, Sarnia and Cornwall. Their eccentric locations appear to preclude them from selection as administrative centres.

CHAPTER V

CONCLUSIONS

The aim of this study has been to describe and attempt to explain the spatial arrangement of a group of politically oriented agencies in Southern Ontario. The principal conclusions of the analysis have already been set out at various stages in the study. This chapter serves to provide an overview of these conclusions and also indicates future lines of research that might prove profitable. The basic premise of this study rests on the belief that to comprehend political organization of space, it is necessary to understand interaction over space. This is summarized by <u>Wolfe</u> who claims that

> "one fact underlies political events and political
> institutions; they always involve men interacting
> over distance. Ultimately political organization
> is spatial organization."[1]

With this in mind, this study has attempted to devise quantitative measures of the way in which space is organized for the administration of <u>human service</u> agencies. Distance or separation of people in space is fundamental to the study of interaction. This research has concentrated on the variable of distance, as applied to the separation of people and administrative centres in the study area.

For each administrative unit of each agency, a measure of compactness was calculated; this was termed the moment of inertia. The value of this varied according to the distribution of the population

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[1] R.I. Wolfe, <u>Transportation and Politics</u>, (New Jersey: D. Van Nostrand Company, 1963), p. 7.

and the location of the administrative centre. An optimal location for the administrative centre was calculated by minimizing the moment of inertia for the area. This placed the new centre at the centre of population gravity. Using the actual and the optimal location of each centre an _index of efficiency_ was derived for each administrative unit.

The study also attempted to compare the efficiency of the regionalization schemes of the agencies. Using data derived from the first part of the study two ranking scales were devised. The first was based on an _index of efficiency_ for each agency. This index was derived by calculating the mean of the indices of efficiency of the constituent units. The second ranking was based on the moment of inertia of each agency. The logarithm of the sum of the moments of inertia of the constituent units was used.

A qualitative analysis of the criteria used for delimiting administrative areas and locating administrative centres was presented in the first part of chapter three. This section of the study rested on data provided by interviews and questionnaires. In attempting to decentralize the administration of services, the agencies have divided Southern Ontario into administrative units. The qualitative study indicated that the aim, for all agencies, was to equalize the work load among the smaller units.

It is postulated that the work load is a function of personal interaction within the administrative area. The degree of interaction is influenced by the separation of people from the administrative centre, therefore as the moment of inertia measures this separation it is further postulated that the value of the moment of inertia is

related to the magnitude of the work load. Table 1 summarizes the findings of the moment of inertia study. The same table can be used to indicate the variation in work load among centres. Areas with the highest work loads appear to be centred on Toronto and London.

A study of the frequency of use of administrative centres was presented in chapter four. Centres were also ranked according to their population size and the moment of inertia of the areas they served. From this analysis it appears that the most important centres in Southern Ontario for the administration of human service agencies are Toronto, London, Ottawa, Chatham, Hamilton and Kingston.

Regarding the specific shapes of administrative areas there are two patterns which characterize the south-western part of the study area, that is, the area lying south-west of an imaginary line from Midland to the eastern edge of Metropolitan Toronto. The first pattern is exemplified by the regionalization scheme of the Department of Economics and Development. This agency divides the area into administrative units with boundary lines extending approximately north-south and east-west. The area between Georgian Bay and Lake Erie is divided into five administrative units. The second pattern is provided by the arrangement of administrative units used by the Department of Education. In this case the same area is divided into three administrative units and the boundary lines extend north-south. The other agencies tend to use a combination of these two basic patterns. Future research could be concerned with a study of the flow of goods, services and people across the boundaries of agencies, and an attempt could be made to assess which arrangement of boundaries is most satisfactory in terms of minimizing interaction across boundaries.

The south-western part of Southern Ontario contrasts with the rest of the study area in two respects. Firstly, the size of the administrative areas appears to be smaller in the south-west.[2] Secondly, the administrative centres tend to be both centrally located and peripherally located within the administrative areas; this contrasts with the rest of the study area where the centres tend to be predominantly located at the periphery of administrative areas. Examples of peripherally located centres are Ottawa, Kingston, Belleville, Oshawa, and Port Hope. Centrally located centres are exemplified by Chatham, London and Stratford. Such centres as Toronto, Hamilton and Owen Sound can be classed as having periphery locations with respect to the administrative areas in the south-west. However detailed examination of the maps for all agencies indicates some variations on this basic theme. For example, for the Ontario Provincial Police regionalization scheme Perth can be classified as a central location within an area in eastern Southern Ontario. In the case of the Department of Highways, Bancroft provides a similar example.

The examination of the administrative systems indicates that there is a relationship between the location of centres and the main highways. The majority of centres are located at or near the main east-west highway in Southern Ontario, this is highway 401; centres are also situated near the Q.E.W. and serve the Toronto-Niagara area. Lindsay and Peterborough lie on highway 7, this is another important east-west highway. In south-west Southern Ontario several centres lie

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[2]For example see the regionalization maps of the Department of Economics and Development and the Department of Transport. (Fig. 5 and Fig. 12)

at the intersection of highways. For example, Wingham is at the junction of highways 4 and 86, and Mount Forest is at the junction of highways 89 and 6. The latter highway provides the most rapid access to the Bruce Peninsula. Ottawa, the federal capital, is used as an administrative centre by six agencies.

This study suggests that administrative centres are located in a large city or town which is

1. close to the centre of the administrative area, or

2. close to a main highway or at the junction of routeways, or

3. close to a special function, for example research facilities as provided at a university, or near an international crossing point.

In this research no attempt has been made to order the preferences in the location of the centres. This work could form the basis of a multiple-regression model of administrative centres in future work.

From the work carried out in this research, it has not been found possible to discover precisely the forces which have influenced the shape and size of the administrative units of the agencies. From the qualitative part of the study, it can be suggested that the shape and size of the administrative units is influenced by the distribution of the population and the intensity of the road network. In general terms, where the density of population is greatest and the road network most intense, the administrative areas appear to be smaller than in the areas where the population density is lower, and the road network less intense. The writer suggests that this results in the basic difference in the size of administrative areas between south-west Southern

Ontario and the rest of the study area. One of the aims of this study has been to provide precise quantitative data to describe the size and shape of the administrative units of the agencies. Therefore to say more, in qualitative terms, about the pattern of the administrative units created by the agencies would not be in accord with the spirit of this research.

To test the efficiency of the shape and size of the administrative units an _index of efficiency_ was derived. The validity of this index was tested using regression analysis. The _index of efficiency_ for the eight agencies[3] varied from .860 to .679. From this analysis it appears that the Ontario Hospital Services Commission regionalization scheme is the most efficient, and that used by the Ontario Hydro Commission is the least efficient. However within each agency there is a range of indices of efficiency which refers specifically to individual administrative units. The greatest range of values within a single agency, is provided by the Ontario Provincial Police.[4] The index varies from .992 for the area centred on Peterborough, to .320, for the area centred on Long Sault. These are also the extreme values when all the administrative units of all the agencies are considered.

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[3]This is the mean of the indices of efficiency of the constituent units.

[4]The centres established by this agency appear to serve several distinct functions, and therefore an analysis which only considers the location in terms of the population distribution has limited validity. The centre at Long Sault, for example, appears to have been located principally because of its closeness to an international crossing point. The optimal location for the centre for this administrative area is about forty miles north-west of Long Sault. This would place the centre near Ottawa.

At the beginning of this chapter it was stressed that this study concentrated on the distance variable. It used air-line distance as a measure of separation. Future research could use a modified measure of distance, for example, the time or cost to reach the administrative centre from all settled points in the area. This would appear to be more meaningful than air-line distance in assessing the functional efficiency of an administrative unit. A new index of efficiency could be derived which would be based on the revised distance variable. A further modification of the index could be introduced by considering "space preferences", and the variables which influence choice and individual decision-making. The index of efficiency used in this study is an attempt to offer a measure of how closely an actual arrangement approximates to an optimal arrangement.

This study has attempted to appraise the present arrangement of administrative areas and the location of centres in Southern Ontario. The findings of the quantitative analysis indicate that the present arrangement of areas and centres is inefficient. This is in accord with the qualitative studies of administrative areas in Southern Ontario by Krueger[5] and Dolbey.[6] However, this study offers an index to indicate the degree of efficiency of each unit and each agency. In future research and planning, it may be desirable to consider the most inefficient arrangements first, and so make the most radical improvements at outset. The index provided in this study might assist in this work.

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[5] R.R. Krueger, op. cit.

[6] S.J. Dolbey, op. cit.

To alter the spatial arrangement of an administrative system it is possible to consider two approaches. The first is to relocate the administrative centre within the administrative area, and the second is to select a centre and redefine the boundaries around the area to be served by the centre. This study has concentrated on the first approach. To help in the selection of administrative centres, the findings presented in chapter four may be used. The analysis indicates that there are thirteen centres which are used more than once. The percentage analysis divides these thirteen centres into ten groups. The most important centres for the administration of human service agencies in Southern Ontario appear to be Toronto, London, Ottawa, Chatham, Hamilton and Kingston. The least important centres include Stratford, Peterborough, St. Catharines and Burlington, as well as the nineteen centres which are only used once. (See Table 7). The three urban centres Windsor, Sarnia and Cornwall are not used by any of the agencies examined in this work.

In general terms this research has used qualitative and quantitative techniques to describe and optimize the spatial arrangement of eight human service agencies for the case of Southern Ontario. It has also provided a test of a quantitative methodology. Criticism of the methods has been provided, and suggestions for improvements and future research have been made. It is hoped that this research falls into the class suggested by Prescott when he states

> "it is hoped that the precise statistical data, associated with internal boundaries, will make it possible to develop more exact methods for their analysis."[7]

[7]J.R.V. Prescott, op. cit., 1965, p. 179.

Finally, there would seem to be a rich source of collaborative interest with other social scientists now studying spatial organization, including economists, political scientists, regional scientists and ekisticians.

APPENDIX A

A list of all the branches of the Government Departments as well as details a propos Commissions, is provided in the Directory and Guide to the Services of the Government of Ontario.[1]

The list of human service agencies below is not exhaustive; it includes those agencies thought by the writer to be most important in the provision of services to the population of Southern Ontario.

Agriculture, Department of
        Home Economics Branch
        Ontario Food Council

Attorney-General, Department of
        Administration of Justice Division
        Ontario Police Commission
        Ontario Provincial Police[2]
        Public Safety Division

Civil Service, Department of
        Public Service Grievance Board

Economics and Development, Department of
        Economic Planning Branch
        Ontario Development Corporation
        Ontario Economic Council
        Ontario Housing Corporation
        Regional Development Branch

Education, Department of

Health, Department of
        Alcoholism and Drug Addition Research Foundation

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[1] Department of Tourism and Information, 1966 Directory and Guide to the Services of the Government of Ontario, Department of Tourism and Information, Toronto, 1966.

[2] Agencies which are underlined have been examined in this research.

Highways, Department of
Planning Branch
Research Branch
Services Branch

Hospital Services Commission, Ontario

Hydro-Electric Power Commission of Ontario

Labour, Department of

Municipal Affairs, Department of
Community Planning Branch

Public Welfare, Department of

Reform Institutions, Department of

Transport, Department of
Highway Safety Branch
Vehicles Inspection Branch

APPENDIX B

A list of the representatives of the agencies is provided below. The representatives were interviewed (underlined) or they answered questionnaires.

Department of Economics and Development — Mrs. A. Cameron

Department of Education — Mrs. M.L. Gaby (Information Officer)

Department of Highways — Mr. O. Harron (Public Relations Officer)

Ontario Hydro Commission — Mr. J.J. Knights (Editorial Officer

Ontario Hospital Services Commission — Mrs. H. Bain (Senior Economist, Hospital Planning, Statistical Research Division)

Ontario Provincial Police — Mr. T.H. Trimble (Deputy Commissioner)

Department of Public Welfare — Mr. J. Nywening

Department of Transport — Mr. F.J. Pillgrem (Deputy Registrar of Motor Vehicles)

APPENDIX C

This contains a summary of some recent literature on the
application of quantitative techniques in the analysis of compactness,
central tendency and minimal aggregate travel.

Within the framework of political science Weaver and Hess[1]
have employed the moment of inertia principle to overcome gerry-
mandering and produce voting districts which are constitutionally
equal and compact. Silva's[2] thesis considers two aspects of the U.S.
political structure; apportionment of elective offices and the form
of the election districts. She deals in detail with the concept of
population compactness. Court,[3] Porter[4] and Hart[5] discuss the merits
of using minimal aggregate travel as an index of compactness. Hart[6]
concludes, "the point of minimal aggregate travel provides a theor-
etical optimum location for regional service centres".

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[1]J.B. Weaver and S.W. Hess, op. cit.

[2]R.C. Silva, op. cit.

[3]A. Court, "The Elusive Point of Minimal Travel", Annals
Association of American Geographers, Vol. 54, No. 3, (Sept. 1964),
pp. 400-3.

[4]P.W. Porter, "A Comment on 'The Elusive Point of Minimal
Travel'", Annals Association of American Geographers, Vol. 54, No. 3,
(Sept. 1964), pp. 403-6.

[5]J.F. Hart, "Central Tendency in Areal Distributions",
Economic Geography, Vol. 30, No. 1, (Jan. 1954), pp. 48-59.

[6]J.F. Hart, Ibid., p. 59.

Court, commenting on Porter's mathematical proof of the precise location of the point of minimal aggregate travel states, "its (point of minimal aggregate travel) analytical determination, however, remains an unsolved problem of considerable difficulty".[7]

The recent publication by Neft[8] devotes a section to the measurement of the second moment of a distribution. This is the moment of inertia. Centrographic techniques, and coefficients and indices of areal distributions are discussed by Duncan, Cuzzort and Duncan.[9]

[7]A. Court, op. cit., p. 403.

[8]D. S. Neft, Statistical Analysis for Areal Distributions, Monograph Series Number Two, Regional Science Research Institute, Philadelphia, 1966.

[9]O. D. Duncan, R. P. Cuzzort and B. Duncan, Statistical Geography, (Illinois: The Free Press of Glencoe, 1961).

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4. --------, and GARRISON, W.L., "The Functional Bases of the Central Place Hierarchy", Economic Geography, Vol. 34, 1958, pp. 145-154.

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