GORDON, David, 1938-
A SYSTEMS CONCEPT FOR THE CONSISTENT DETERMINATION OF MANPOWER IN A MUNICIPAL ORGANIZATION.

The University of Oklahoma, D.Engr., 1969
Engineering, industrial

University Microfilms, Inc., Ann Arbor, Michigan

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

A SYSTEMS CONCEPT FOR THE CONSISTENT DETERMINATION OF MANPOWER IN A MUNICIPAL ORGANIZATION

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF ENGINEERING

BY

DAVID GORDON

Norman, Oklahoma

1969

A SYSTEMS CONCEPT FOR THE CONSISTENT DETERMINATION

OF MANPOWER IN A MUNICIPAL ORGANIZATION

APPROVED BY

B. L. Foote

DISSERTATION COMMITTEE

To my wife, Susan,

without whom nothing

would be possible

ACKNOWLEDGEMENTS

"It is well to give when asked, but it is better to give unasked, through understanding . . . ."

-Kahlil Gibran, The Prophet

It is for this and much more that the author wishes to thank Dr. Robert A. Shapiro, Dr. B. L. Foote, Dr. Raymond P. Lutz, and Professor Robert L. Lehr, each for his own unique personal contribution to the realization of this effort.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

Within the next twenty years we shall, in all likelihood, make the decisions that will determine eventually whether this new human habitat, the metropolitan area, will become the most expensive jungle or a place fit to be the City of Man.

-- Peter F. Drucker, 1962

CHAPTER I

INTRODUCTION

Local American government is characterized by a constantly changing membership over time. This state of flux precipitates changing and ever-evolving objectives, for the nature of local government, in the American tradition, dictates such a system. As government alters trajectory under pressure from its changing elements, public decisions will be made concerning human resources, decisions which will shape the municipal organization for years to come.

Because manpower allocation has future implications, it also implies future commitments. Consistent estimates of future manpower requirements are therefore necessary in order to make current decisions. However, because of the absence of a theoretical base, planning decisions involving human resources are made without a comprehensive understanding of the problem of manpower and its reciprocal impact between activity centers within municipal organizations. Unless a sufficiently theoretical concept can be determined, assessments of manpower requirements will continue to be ineffective.

This has become evident in recent years, particularly since 1945, as local governments have suffered a continuing erosion of their human resources.[1] Presently, "most public administrators are hard pressed to keep their cities operating from day to day,"[2] for the human resources of any enterprise must be continually replenished, and personnel in various areas must be brought into the system when and where needed. In relation to these obvious needs, local governments are notably and consistently weak in advancing manpower planning.[3]

As early as 1933, Dr. Roscoe C. Martin stated in his article "Manpower for Cities" that

> . . . one of the chief problems of the cities today is manpower. The cause of the problem is a simple one -- the cities find it almost impossible to project their needs for manpower in the years to come . . . . Unless basic research is done and new and practical tools developed, conditions will get worse before they get better.[4]

As if in fulfillment of Martin's prophecy, one facet of a national two-year study conducted by the Municipal Manpower

---

[1] Governmental Manpower for Tomorrow's Cities: A Report of the Municipal Manpower Commission (New York: McGraw-Hill Book Co., Inc., 1962), p. 85.

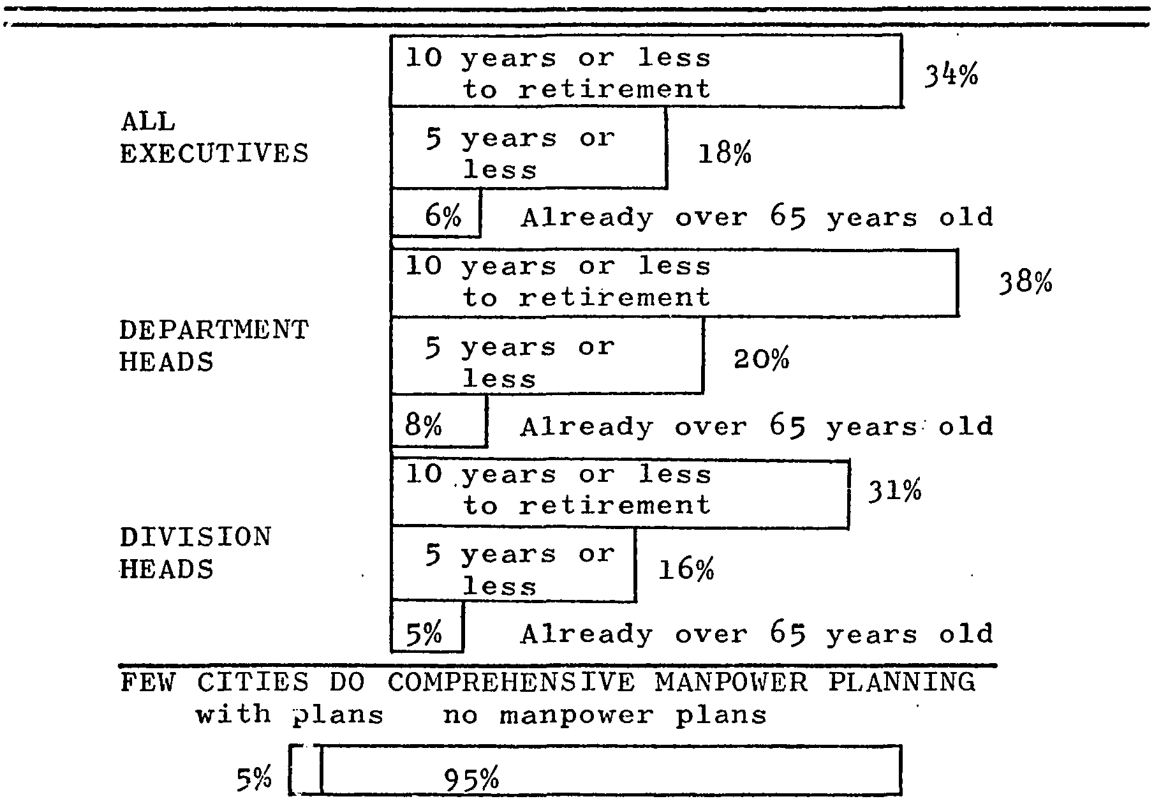
[2] Cyril Herrmann, "The City As a System," Science, Engineering, and the City (Washington, D. C.: National Academy of Sciences, 1967), p. 118.

[3] Governmental Manpower for Tomorrow's Cities, op. cit., p. 80.

[4] Roscoe C. Martin, "Manpower for Cities," Public Management, XLVI (Chicago: International City Managers' Association, 1963), 26.

Commission concluded as late as 1962 that "municipal management often finds itself unable to determine its own manpower requirements . . . ."[1] Further, "only three out of sixty units [major metropolitan areas] investigated by the Commission attempt advance planning of manpower needs . . . .[2] In a significant number of instances, local governments are living on the 'fat' of the manpower they were able to recruit during the depression Thirties."[3] (Figure 1)

Figure 1.--Municipal Executives Close to Retirement[a]



[a] *Governmental Manpower for Tomorrow's Cities*, *op. cit*, p. 86.

---

[1] *Governmental Manpower for Tomorrow's Cities*, *op. cit*, p. 66.

[2] *Ibid*., p. 80.

[3] *Ibid*., p. 84.

The ensuing study attempts to revitalize Martin's initial observations through research designed to provide the means by which this significant gap may be closed.

Statement of the Problem

To this end, it was the purpose of this dissertation to provide a systems concept[1] for the consistent determination of manpower distribution in a municipal organization. This research develops a viable theoretical base which may be used to provide public policy administrators with a quantitative resource designed to improve the informational and conceptual basis for executive choices with regard to the matter of manpower estimation.

This quantitative resource also provides dependent as well as interdependent cross-agency evaluations of manpower requirements without implying or ever assuming a corresponding realignment or shift in the organizational responsibility of governmental functions, thereby maintaining the theoretical integrity of the model.

Of necessity, this research presupposed that the decision maker understands the decision process used in his organization and can place the resultant model in its proper perspective.

---

[1]Anatol Rapoport offers the following definition of the systems concept as (1) something consisting of a set of entities (2) among which a set of relationships exist (3) so that deductions are possible from some relationships to others or from the relationships among entities to the behavior or history of the system. Reference: International Encyclopedia of the Social Sciences, 1968, XV, 453.

Model Functions and Fundamental Properties

To adequately explore this problem requires the development of a systems concept that at least performs the following functions:

(1) Provides an ordered design for the determination of long-range manpower requirements in a municipal organization,

(2) Provides a means of establishing the various interdependencies and interrelationships of those manpower requirements,

(3) Provides a means of estimating total manpower requirement levels,

(4) Provides a method of analyzing manpower strategies or mixes of strategies in order to predict their impact on the total municipal organization.

The essence of this research did not address itself to the technical process of recruiting, examining, record keeping, or other details of personnel administration which may be delegated to specially trained personnel. This did not minimize the importance of these responsibilities, but instead placed them in proper perspective in the hierarchy of problems facing those concerned with municipal management. That is to say, this writer asserts that the mandatory length of experience to be required of public health nurses is of no concern until it is meaningfully determined that additional public health nurses are indeed necessary.

Those fundamental properties which were identified for prime consideration in the development of the model are as follows:

(1) Municipal activities are simultaneously related in a dependent as well as interdependent nature.

(2) Municipal services are significantly consumed by differing sectors of the municipality in varying intensity.

(3) Public service demand rates are inherently sensitive to the constantly changing trends in municipal population congestion.

(4) Municipal policy implementation may be a function of public mood rather than administrative decree.

(5) Municipal services are provided under essentially monopolistic conditions.

The preceding considerations provide the context within which this investigator offers the following research findings which delineate the complexities involved in comprehensive manpower forecasting for the municipal organization.

CHAPTER II

ORIENTATION TO THE PROBLEM OF MUNICIPAL MANPOWER REQUIREMENTS

Urban Growth and the Demand for Municipal Services

The large, rapid, and insistent increase in the demand for services that plagues the local governments is an inevitable accompaniment of urban living.

Two-thirds of all Americans already live in metropolitan areas,[1] and in the decade 1952-1962, the metropolitan population increased by 29,000,000, or 35 per cent.[2] Practically all of the country's population growth occurred in the metropolitan area.[3] Basically, this growth is a result of rapid increase of U. S. population (Figure 2), for which there are many reasons: better health and longer lives, widespread prosperity and larger families; a bumper crop of

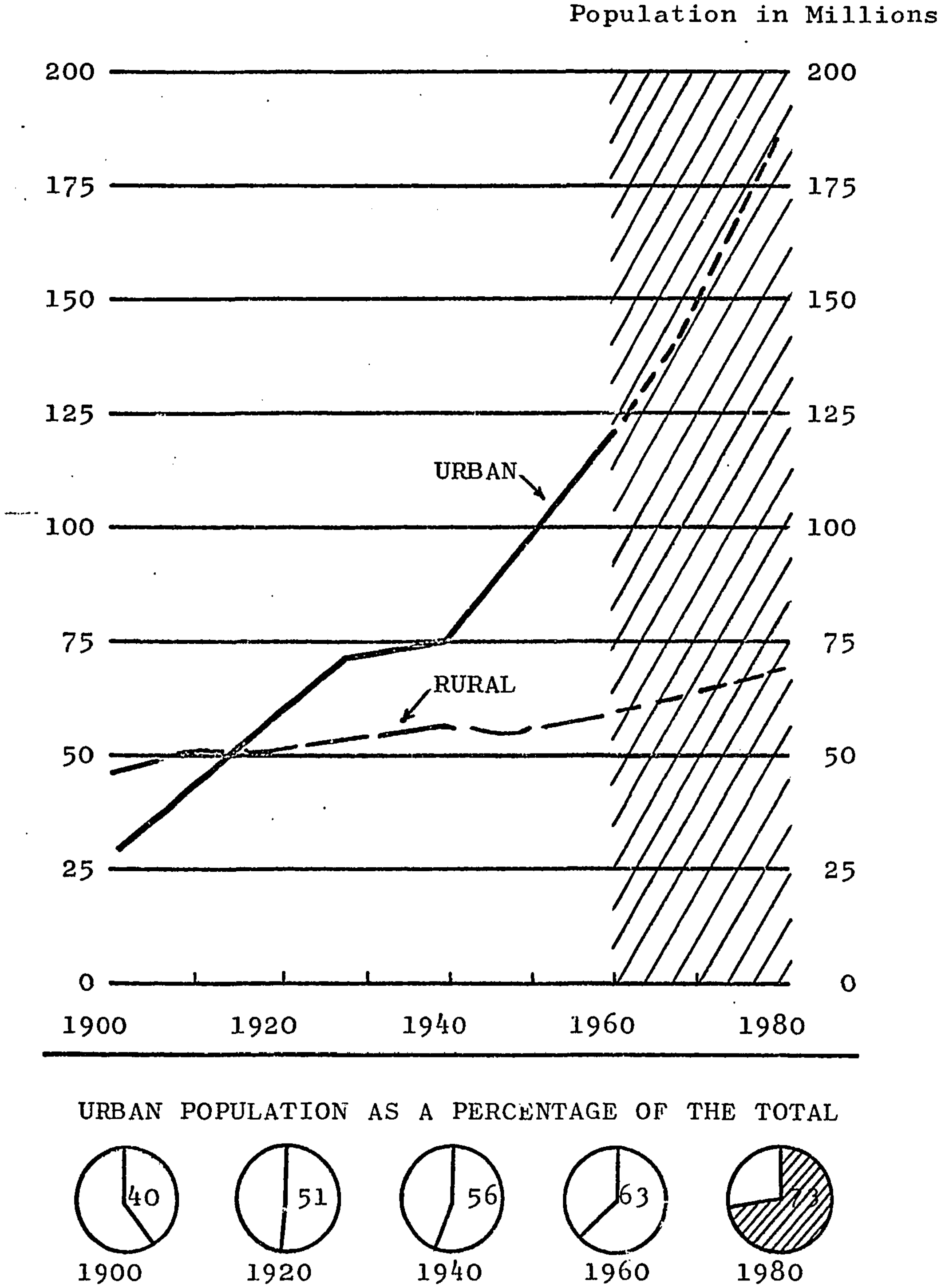
---

[1]The term metropolitan area commonly refers to a major city together with its suburbs and those nearby cities over which the major city has an influence. Reference: D. J. Bogue, The Structure of the Metropolitan Community (Ann Arbor, Michigan: University of Michigan Press, 1949).

[2]Governmental Manpower for Tomorrow's Cities, op. cit., p. 3.

[3]Ibid.

Fig. 2.--The Overwhelmingly Urban Trend of the United States[a]



[a]*Ibid.*, p. 4.

post-war children growing into adulthood, getting married, and having children earlier than their parents did.[1] Their continued concentration in metropolitan areas is partially the result of numerous opportunities which are there for nearly every occupation in society.

One result of this concentration is that today's metropolitan problems are formidable; but the future will bring even greater and more complex problems, for there seem to be few foreseeable technological limits on the growth of metropolitan population and geographical expansion for the rest of the century.[2] By 1980, there may be 190,000,000 Americans living in massive metropolitan areas -- more than the total population of this country today.[3] With this expansion, congestion becomes more acute and increased safeguards and conveniences become necessary. Central cities are already being asked to meet demands for expanded social services, improved traffic systems, and the elimination of physical blight. The prevention of crime, juvenile delinquency, mental illness and other anti-social behavior becomes more difficult as the density of population becomes greater and as economic change and technological advances outstrip the individual's ability to adjust.[4] Suburbs, the mecca for those who seek a wholesome neighborhood in the historic

---

[1] Ibid.

[2] Ibid., p. 10.

[3] Ibid.

[4] Ibid., p. 13.

American tradition, must build complete physical plants and urban service systems from scratch.[1]

As a result, urban residents depend on governments as never before to provide services which the individual could perform for himself in a less urban, less complex habitat,[2] while the rapid urbanization of the population has been making the job of providing essential municipal services even larger and more complex.

Municipal Manpower Consumption and the Internal Dependencies of the Government Organization

While it has been established that population increase has a direct impact on demands for services, which can be translated into a corresponding increase in staff requirements, this influence may be further demonstrated in another facet of an already complex manpower problem facing municipal organizations.

As a municipal organization grows, there is also a tendency to inwardly consume an ever-increasing proportion of its manpower as internal dependencies develop to meet the growing demands of this expanding population. To illustrate this point, consider a municipal organization that performs a number of tasks, each consisting of some type of service. If the entire organization is analyzed as a system[3] with each

---

[1] *Ibid.*, p. 8. [2] *Ibid.*, p. 14.

[3] See Chapter III for discussion.

service element as a sub-system, it has been established that it becomes economical and practical to arrange the work so that there will be specialized means (i.e., adequate man-power) to perform these sub-system functions. Since, in many cases, a number of these "independent" specialties will be simultaneously required to create the desired organizational output, there is created by virtue of the organization a considerable amount of interdependence. This is substantiated by the work of March and Simon when they state that "the greater the specialization by sub-systems, the greater the interdependence among organizational units."[1]

As examples, today, unlike a decade ago, it is not unusual to find municipal aerial cartographer departments aiding city finance departments to assist in property assessments, departments of geology working with building inspection departments to advise on the maximum number of septic tanks that a certain type of soil can absorb, or staff from the traffic departments and computer sections engaged in traffic pattern analysis.[2]

In a well-run city, the various departments are aware of the independent functions of the others and draw upon those strengths when needed to bolster their own function.[3] John M.

---

[1]James G. March and Herbert A. Simon, Organizations (New York: John Wiley and Sons, Inc., 1966), p. 159.

[2]Governmental Manpower for Tomorrow's Cities, op. cit., p. 22.

[3]John M. Pfiffner, Municipal Administration (New York: The Ronald Press Company, 1940), p. 36.

Pfiffner in his text Municipal Administration highlights the interdependence of municipal organizational units with the following simple statement: The municipal organization is a unit with the cells very much interrelated.[1] He goes on to cite numerous examples of interdepartmental dependency. One of these examples is the problem of juvenile delinquency, which may have recreational, welfare, and health, as well as police aspects.[2] Another example of this vital interplay comes under the heading of "fire fighting and prevention." This activity requires the cooperation and sharing of personnel in several departments.[3] Consider the act of answering a fire alarm. When the alarm sounds, it sets off a chain reaction for the demand of municipal personnel. In addition to alerting fire fighting personnel, a signal is instantaneously transmitted to the water pumping station so that water pressure consistent with the alarm may be applied by personnel from that department. The police are at the fire as soon as the firemen for the purpose of policing crowds and controlling traffic. When municipally owned, gas and electric utilities maintain crews on duty for such emergencies. These crews cut wire cables and conduits and relocate them for purposes of maintaining service as well as preventing the spread of fire.

Yet the role of the fire department cannot be analyzed

---

[1]Ibid., p. 34. [2]Ibid., p. 22.

[3]Ibid., p. 265.

as simply as the above example might suggest. A municipal fire department, also highly concerned with fire prevention, is the unit which is quite often charged with the enforcement of the building codes and ordinances. Since all progressive cities have ordinances regulating the manner in which buildings shall be constructed, corps of inspectors are constantly visiting and watching the entire construction process. Because economic returns do not permit the construction of an absolutely fireproof city -- a dilemma which building codes must recognize, the maintenance of structural standards is a struggle between what is economically feasible and ideally desirable. As a result, continuous consultation between appropriate fire department personnel and representatives of the city's engineering department is required.[1]

As a second illustration, the history of the park system in this country serves as an excellent example of how municipal services have grown and how they have come to be highly interdependent in their use of personnel. At the beginning of the present century, park administrators were landscape minded, while the lay boards which headed the park departments were composed of persons interested in the formal aspects of park development.[2] The result was that there often prevailed in park administration a philosophy that park beauty should not be profaned by the vulgarizing impact of the masses participating in athletic and other outdoor recreation.[3]

---

[1] Ibid., p. 281. [2] Ibid., p. 533. [3] Ibid.

Simultaneously, at the close of the nineteenth century, the deteriorating influences of urban industrialism were forcing themselves upon the attention of humanitarian philanthropists. Large slum areas had little or no play and recreational facilities for children. The result was an attempt on the part of private and social agencies to acquire and develop playground centers in these areas.[1]

Thus, today it is not unusual to find in addition to the park organization an entirely separate unit devoted to play and recreation.[2] However, the last decade has seen park administrators and recreation directors coming closer together. The park systems of the country have developed and continue to develop recreational facilities quite extensively while recreational personnel have become more aware of the need for beautification of their premises.[3]

Nevertheless, the park system we have today is not the sole product of the park and recreation departments. Vital to this on-going effort are the departments of engineering, construction, and maintenance.[4]

To further dramatize this extensive interdepartmental dependence, we see the recreation department becoming an important cog in the community-wide effort to reduce juvenile delinquency. Here the seemingly simple function of what was

---

[1] Ibid.

[2] Ibid.

[3] Ibid., p. 534.

[4] Ibid.

once the development of organized play is now called upon to "work hand in hand with police, school authorities, social workers, and welfare department representatives to prevent delinquency."[1] This development of a recreation program as a municipal activity has given rise to questions concerning future manpower requirements to implement the department's primary function and still service the requirements of the other departments within the municipal organization.

Therefore, questions regarding the number of equivalent recreational personnel who will be devoted to serving police and welfare department demands, for example, now become relevant. In addition, if our population does continue to grow and if indications of a shorter work week translated into increased leisure time are realized, how much additional recreational manpower will be required and how will this manpower be absorbed -- externally, servicing the populous, or internally, servicing other departments within the complexities of the city? Significantly, the chief problem of modern public management is this coordination of manpower requirements, i.e., the working together of the various subdivisions of the city.

Clarence E. Ridley and Orin F. Nolting in their treatise, How Cities Can Cut Costs, demonstrate even further the high degree of departmental interdependence by making the

---

[1] Ibid., p. 542.

following comment with regard to the traditional Public Health Department, a statement supported by the International City Managers' Association:

> Health services have a social aspect of which public health personnel must be conscious and should seek the help and advice of a social worker, medical or otherwise.[1]

One can continue to build this mosaic of interdependency by noting, as do Ridley and Nolting, the seldom compensated for but frequent relationship between the Public Health Department and other departments such as Sanitation, Building, Sewer and Water.[2] Additional statements not only address themselves to Public Health, but also to Welfare, Public Works, Police Administration, and Fire Administration, among others.

A final example of service departments with a high degree of interdepartmental relationships is that of the Police Department. Initially, police automotive and radio equipment was sold to municipalities with the assumption that the cost would be absorbed by reduced manpower.[3] However, this did not occur and police departments have continuously increased their manpower. One of the major causes for this

---

[1]Clarence E. Ridley and Orin F. Nolting, How Cities Can Cut Costs (Chicago: International City Managers' Association, 1933), p. 34.

[2]*Ibid*., p. 35.

[3]Herbert A. Simon, "Organization and Management," Planning for Postwar Municipal Services (Chicago: International City Managers' Association, 1945), p. 43.

growth has been the previously described population expansion.[1] The second major reason is that, sad to say, the police force has become a sort of municipal waste basket; functions not readily assigned elsewhere are placed in its keeping.[2]

For example, although the department's chief task is to enforce the law of the state and city, as well as to preserve the peace, in recent years it has been called upon to shoulder the enormous burden of regulating an ever-increasing flow of traffic. Because this additional involvement precipitated by urban congestion has also placed a greater burden on the ingenuity of the police department, it is not uncommon to see police personnel acting in conjunction with traffic engineers to solve the problem of traffic safety.

An important part of the traffic safety program is traffic education. Additional police manpower is devoted to this activity, in one way, by working extensively with other departments of the municipal organization, e.g., recreation and the public school system. In addition, laboratories giving various psychological and psychiatric tests to determine why certain people are accident prone are almost always staffed by police manpower, although not the uniformed

---

[1] _Ibid._

[2] Austin F. MacDonald, _American City Government and Administration_ (New York: Thomas Y. Crowell Company, 1951), p. 498.

officer.[1]

Aside from these direct duties, the police department is charged with a long list of indirect ways in which its manpower is employed. As examples, the Welfare and Public Health Departments use police manpower extensively for escort and inspection services, while Public Health and other departments which issue licenses use the police department's manpower for the issuance of these licenses. Further, the municipal hospital frequently employs police manpower to provide ambulance service.

Thus, the factors of departmental interdependency and population expansion clearly have a direct impact on the critical municipal manpower determination problem currently facing local government.

Public Mood and the Municipal Standard of Living

However, still greater complexity results if the mood of the public dictates that it can tolerate a poor grade of municipal services or that it cannot afford a better grade. It is not for the chief executive or the department head to substitute his judgment for that of the populace.

Because modern man needs to feel that he has some control over his own destiny and can, in fact, influence the basic decisions on which his welfare depends,[2] it is the

---

[1] Simon, *op. cit.*, p. 47.

[2] Harlan Cleveland, "A Philosophy for the Public Executive," in *Perspectives on Public Management: Cases and*

citizen, through elected representatives and through such devices as referendums, opinion polls, and public hearings, who determines what the municipal "standard of living" shall be. For example, the fire chief may point out that certain expenditures of manpower will be required if the fire insurance rate is not to be raised, and the police chief may submit his expert judgment that the robbery problem will become serious unless he can put additional patrolmen on the street; but it is still up to the people of the city to decide, after they have heard their experts, whether such manpower requirements are worth their cost, and whether the allocation for fire protection is more important or less important than that for police protection.[1]

At this point, it cannot be stressed enough that there is no such thing as the "proper" standard of service or "minimum adequate" standard of service that a city ought to maintain.[2] By the same token, it is impossible to determine by the application of any scientific yardstick that a city is spending too much for manpower to perform a particular service -- i.e., maintaining too high a standard.[3] The question is, what does a city want? What standard of municipal

---

Learning Designs, edited by Robert T. Golembiewski (Itasca, Illinois: F. E. Peacock Publishers, Inc., 1968), p. 19.

[1]Technique of Municipal Administration, The, Third Edition, 1947 (Chicago: International City Managers' Association), pp. 148-149.

[2]Ibid., p. 155. [3]Ibid.

services do the citizens desire, and what are they willing to pay for?

It therefore seems reasonable to conclude that the nature of the municipal organization to formulate and carry out a comprehensive program of municipal services is also related in a significant way to the relative influence exercised by public individuals.

CHAPTER III

VALIDITY OF THE SYSTEMS CONCEPT IN ORGANIZATION THEORY

Relevance of the Systems Concept to Organizational Structure

As previously stated, the local American municipal organization can be characterized by change. Yet, as prevalent as this change appears to be, it is so sufficiently unobtrusive that many people, even those a part of the organization, do not recognize that it is occurring. As was demonstrated, lack of perception of change with regard to manpower resource estimation within municipal organizations is well documented. To understand the basic changes which are taking place, it is useful to begin by considering the structure which not only was, at one time, universal and is still present in organizational thought, but is also mistakenly used as a term which characterizes the municipal organization -- the bureaucracy.

The bureaucracy is characterized by a number of fixed jurisdictional areas, each with official duties and each with individuals who have authority regarding the discharge of these duties. The bureaucracy operates according to fixed rules.

Primary advantages of this form of governmental organization have been argued by Max Weber.

> Bureaucratization offers above all the optimum possibility for carrying through the principle of specializing administrative functions according to purely objective considerations. Individual performances are allocated to functionaries who have specialized training and who by constant practice learn more and more. The 'objective' discharge of business primarily means a discharge of business according to calculable rules and without regard for persons.[1]

It is now recognized, however, that Weber's view of rigid authority patterns does not assure the accomplishment of goals. In fact, it has been vividly illustrated that the inflexibility of the bureaucratic system may not even be a good way of assuring a high likelihood of achieving goals.[2]

To this researcher, a more incriminating assumption of the bureaucratic model is that of the verticality of the organizational form. When compared to the actual interdependencies that exist within an organization, many of the assumptions surrounding the bureaucratic model seem to be based on a theoretical concept of an organization which does not, in reality, exist. Further research establishes that in actuality, today's municipal organizations take on a form

---

[1] David I. Cleland and William R. King, introduction to Systems, Organizations, Analysis, Management: A Book of Readings (New York: McGraw-Hill Book Company, 1969), p. 2, quoting Max Weber, Essays in Sociology, edited and translated by H. H. Gerth and C. Wright Mills (Fair Lawn, New Jersey: Oxford University Press, 1946).

[2] Cleland and King, op. cit., p. 2.

vastly different from the bureaucratic model and the condemnation of these organizations as bureaucratic is vastly overstated.

That is, the structure of the modern municipal organization has been subordinated in favor of flows of relationships necessary to sustain the modern organization in its environment. This deemphasis on the parochial goals of functional units and the corresponding emphasis on total system interrelatedness is implicit in the systems approach to organizational thought. This approach to municipal organizations is the antithesis of the bureaucracy with the latter's neatly defined areas of endeavor. The systems concept presumes that interactions at appropriate levels are analyzed and utilized to understand the total system.

Of necessity, the systems approach to municipal organization involves a view of as large a system as feasible in terms of the organization's activity centers and their interrelationships. This realization is the essence of the systems viewpoint followed by this researcher. Thus, as related to this research, the basic difference between the bureaucratic approach and that of the systems concept is the difference in how organizational structure is viewed. The bureaucracy is a hierarchical structure. The systems view of the organization is one of a structure that involves a set of flows -- in this case represented by the sets of human resources within the organization and their interaction with one another and the market they serve.

Pervasiveness of the Systems Concept in Organizational Thought

To illustrate the pervasive role of the systems concept in current organizational thought, outstanding authorities in the area of organization theory are cited. The following broad range of current organizational definitions has been contributed by Barnard, Simon, Parsons and Bakke.

Barnard defines "organization" in several ways, but always as what he terms "a system of consciously coordinated activities or forces of two or more persons."[1] This system includes several persons as well as several components.

> A cooperative system is a complex of physical, biological, personal, and social components which are in a specific systematic relationship by reason of the cooperation of two or more persons, for at least one definite goal.[2]

Thus, to Barnard an organization is a system of cooperative, coordinated (integrated) human activities. These activities are processes for creating, transforming, and exchanging "utilities."[3] That is, they are processes which convert input to output.

Simon, although emphasizing decision-making processes, closely follows Barnard in that he also stresses both the

---

[1]Chester I. Barnard, The Functions of the Executive (Cambridge, Mass.: Harvard University Press, 1954), p. 73.

[2]*Ibid.*, p. 66. [3]*Ibid.*, pp. 58, 240.

concept of organizations as systems and the concept of communications as the process for insuring coordination.

> Human organizations are systems of interdependent activity, encompassing at least several primary groups and usually characterized by a high degree of rational direction of behavior toward ends that are objects of common acknowledgement and expectation.[1]

Parsons links the organization, which he considers as a social system, to other systems. He states that an organization is "a social system oriented to the attainment of a relatively specific type of goal, which contributes to a major function of a more comprehensive system, usually the society."[2] More specifically, Parsons views an organization as a system of exchange.

> An organization is a system which, as the attainment of its goal, 'produces' an identifiable something which can be utilized in some way by another system; that is, the output of the organization is, for some other system, an input.[3]

Bakke considers organization in terms of four constituent elements:

> (a) the organizational charter that formally serves to legitimate organizational goals and activities;
>
> (b) basic resources used in organizational activities, including human;

---

[1]Herbert A. Simon, "Comments on the Theory of Organization," American Political Science Review, XLVI (December, 1952), 1130.

[2]Talcott Parsons, "Suggestions for a Sociological Approach to the Theory of Organization - I," Administrative Science Quarterly, I (June, 1956), 63.

[3]Ibid., p. 65.

(c) "activity processes" that serve in acquiring and utilizing those basic resources; and

(d) "bonds of organization" that integrate the above into operating systems.[1]

Combining these four constituent elements, Bakke provides this general definition of an organization:

> A social organization is a continuing system of differentiated and coordinated human activities utilizing, transforming, and welding together a specific set of human resources into a unique problem-solving whole engaged in satisfying particular human needs in interaction with other systems of human activities and resources in its environment.[2]

It should be noted at this time that certain elements are common to each of the definitions selected. These elements form a framework for the most prevalent orientations to organizational analysis. Perhaps the most significant common element stressed in definitions from various orientations is the consideration of organizations as systems.[3] That is, organizations are viewed in terms of actions and interactions of members occurring in a systematic fashion. Parsons and Shils have said:

> Internal differentiation, which is a fundamental property of all systems, requires integration. It

---

[1]E. Wight Bakke, "Concept of the Social Organization," in Modern Organization Theory, edited by Mason Haire (New York: John Wiley and Sons, Inc., 1959), p. 37.

[2]*Ibid.*, pp. 37, 50.

[3]Charles F. Harding, "The Social Anthropology of American Industry," American Anthropologist, XVII (Dec., 1955), 1218-1231.

> is a condition of the existence of the system that the differentiated subsystems must be coordinated either negatively, in the sense of avoidance of disruptive interference with each other, or positively, in the sense of contributing to the realization of certain shared collective goals through collaborated activity.[1]

Many approaches deny the existence, or at least the necessity, of the properties of boundary maintenance and the tendency toward equilibrium stressed in the Parsons and Shils definition of "social system." However, exponents of nearly all orientations accept the importance of the properties of (a) differentiation of functions and (b) integration of activities involved in performing functions.[2] It is also generally assumed that organizational systems have members whose activities are purposive in that two or more subsystems pursue primary goals and subgoals through "collaborated activity." These "purposive" activities are the organizational functions carried out by members.[3] Parsons refers to these processes in terms of input-output.

---

[1]Talcott Parsons and Edward A. Shils, _Toward a General Theory of Action_ (Cambridge, Mass.: Harvard University Press, 1951), p. 197.

[2]Edward C. Devereux, Jr., "Parsons' Sociological Theory," in _The Social Theories of Talcott Parsons: A Critical Examination_, edited by Max Black (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1961), p. 27.

[3]James K. Feely, "An Analysis of Administrative Purpose," _American Political Science Review_, XLV (December, 1951), 1069-1080; Dwight Waldo, _The Administrative State: A Study of the Political Theory of American Public Administration_ (New York: Ronald Press Company, 1948), pp. 185-186.

When we come to processes, the components which are parallel to units in a structural sense are categories of input and output, according to the level of system reference conceived either as operating between the system itself and its environment or as between subsystems (units) in relation to each other. Thus, at one level processes may be conceived as the 'passing' or exchanging of inputs and outputs between systems or subsystems.[1]

[1]Talcott Parsons, "The Point of View of the Author," in The Social Theories of Talcott Parsons, op. cit., p. 329.

CHAPTER IV

MODELS FOR MANPOWER PLANNING

Two models for manpower planning germane to the author's research were identified in an extensive survey of pertinent literature. Reviewed herein, each is followed by a brief criticism citing the limitations of the subject model. This section culminates in a summary comparison of both models in light of the functions developed in Chapter I.

Isard-Kuenne Model[1]

Presentation

The first of these models involves the development of employment multipliers used to project estimated total employment in a region as a result of the expansion of a basic industry in that area. The Isard-Kuenne Model is presumably a direct result of Kuenne's research involving his Ph.D. dissertation, The Use of Input-Output Techniques for the Estimation of Employment in the Delaware Valley.

[1]Walter Isard and Robert E. Kuenne, "The Impact of Steel Upon the Greater New York - Philadelphia Industrial Region," The Review of Economics and Statistics, XXXV (November, 1953), 289-301.

The results of this work culminated in an article published by Isard and Kuenne, "The Impact of Steel Upon the Greater New York - Philadelphia Industrial Region." Miernyk analyzes this model and the essence of this analysis is presented below.[1]

Isard and Kuenne base their model development on the "agglomeration effect" of the location of a new industry in an area. This is a term taken from location theory[2] and it refers to the various kinds of economic activities in the general vicinity of a newly located firm in a basic industry. It is economical for establishments in some industries to locate near the source of supply of their raw material, especially if this raw material is heavy and bulky with relatively high transportation costs. In addition, if the firm also expects to find a substantial market for its products close to its raw-material source, there will be an even stronger tendency toward agglomeration. What is implied then is that although it is obvious that not all of the output of

---

[1]William H. Miernyk, The Elements of Input-Output Analysis (New York: Random House, Inc., 1966), pp. 50-53.

[2]Spacial economics deals with what is where, and why. The "what" refers to the type of economic entity, e.g., production institutions. "Where" refers basically to location in relation to other economic activity and may be defined in broad terms such as regions. The "why" refers to explanations within the somewhat elastic limits of the economist's competence. Location theory describes this kind of analysis when the emphasis is upon alternative locations for specified industries. Reference: William Alonso, Location and Land Use (Cambridge, Mass.: Harvard University Press, 1964).

a firm using the output of a basic industry can be sold in a local market, the firm will still have a strong incentive to locate near the source of raw materials to economize on transportation costs.

The first three stages of the Isard-Kuenne model are heavily dependent upon location theory, as well as informed judgment. In outline form, the stages amounted to the following:

(1) Estimate the agglomeration effect by analyzing the clustering properties of establishments around similar basic industries in other areas of similar characteristics.

(2) Estimate the shifts in production that would occur between older areas and the one in which the new facility was being located due to a shift in markets that was expected to occur.

(3) Estimate production-worker employment for each "satellite" industry which was expected to be attracted as a result of the formation of the new basic industry.

(4) Estimate a "bill of goods" which would be furnished to the area. This consists of all inputs which would be absorbed by both the basic industry and the satellite industries.

At this point, input-output analysis is introduced to help construct a "bill of goods." Each of the coefficients of the input-output table is multiplied by the dollar volume of its expected production derived from the employment estimates mentioned above. This is done for both the basic and satellite industries to obtain a total input requirement. Following this, the minimum input requirements to be produced in the area are estimated. Miernyk notes that there exists no precise formula for the estimation of local area input requirements and, therefore, it must rely heavily on informed judgment.

With the completion of the above, a table was constructed listing basic as well as satellite industries and the percentage each would contribute to the input requirements which would be produced in the area. The employment multiplier was then derived by a series of expansions. The beginning round was computed by applying the percentage of input requirements to be produced in the area to the total input requirements. This computational technique is an iterative one and is reviewed by Chenery and Clark.[1]

Review

Miernyk, in reviewing the Isard-Kuenne Model, makes the following observations:

> (1) The Isard-Kuenne Model was devised to measure the total employment impact on a region resulting from the location of a new basic industry in that area.
>
> (2) The Isard-Kuenne Model can be employed only if an up-to-date input-output table is available so that input requirements for the basic and satellite industries can be obtained. When this model is applied to an area, it further assumes that the coefficients of a national table apply to the area analyzed.
>
> (3) The Isard-Kuenne Model was designed to project the total employment impact of a new basic industry on an area and thus, in its application,

---

[1]Hollis B. Chenery and Paul G. Clark, Interindustry Economics (New York: John Wiley and Sons, Inc., 1959), pp. 28-29.

it is limited to this specialized process.[1]

Moore-Petersen Model[2]

Presentation

The Moore-Petersen Model is similar to the previously presented model in its intent. The notable difference between the two is that the Moore-Petersen Model bases its development on employment-production functions, as well as consumption functions. The model developed by Moore and Petersen resulted in a study of the state of Utah, the results of which are presented in Review of Economics and Statistics, Volume 37. These results, as well as model development, are also analyzed by Miernyk and are essayed below.[3]

The employment-production function measures the relationship between total employment in each industry and the gross output of that industry. Moore and Petersen employed only linear production functions; i.e., they are simple equations which state that changes in employment are proportional to changes in output.

As illustrated on the next page, the slopes of the employment-production functions are different for different industries. This states that employment in some industries

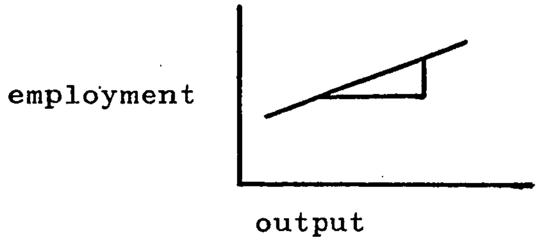
---

[1]Miernyk, *op. cit.*, pp. 50-53.

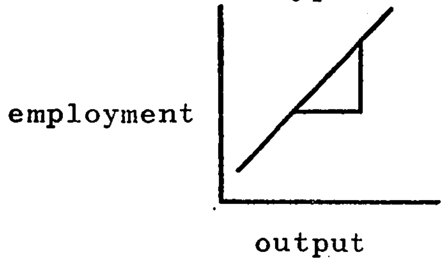
[2]Frederick T. Moore and James W. Petersen, "Regional Analysis: An Interindustry Model of Utah," The Review of Economics and Statistics, XXXVII (November, 1955), 376-377.

[3]Miernyk, *op. cit.*, pp. 53-55.

Typical Industry A



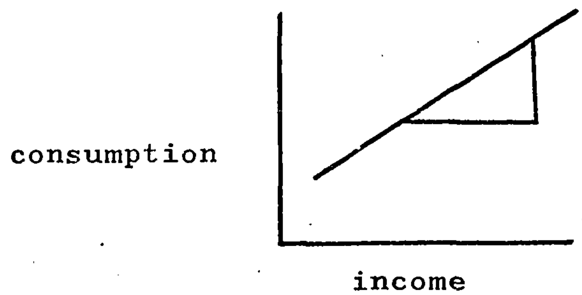
Typical Industry B



will rise more than others if we assume identical changes in the demand for gross outputs of all industries. The slope of each employment-production function, which measures the rate of change of employment as output changes, is employed by Moore and Petersen to measure the direct change in employment associated with increased dollar volume.

At this point, an interindustry table containing direct as well as indirect requirements per dollar volume of output is employed. To obtain the direct as well as indirect effects, each of the coefficients in the table is multiplied by the appropriate employment function (the number representing the slope of each production function), and the results are summed across each row of the interindustry table. This gives the direct and indirect employment effects of a change in the final demand dollar volume. A set of interindustry employment multipliers was obtained for the region by dividing the direct plus indirect employment effect into the direct employment effect.

At this stage, Moore and Petersen extended the above to measure not only the direct and indirect employment effects, but also the induced employment changes by linking the employment-production function mentioned above to that of a set of consumption functions. Like their employment-production function, their consumption functions are also linear: they state that changes in consumption are proportional to changes in income.



The logic behind the linking of consumption changes and employment changes is as follows: An initial change in dollar volume will lead to direct as well as indirect changes in output which, in turn, lead to employment changes described by the employment multiplier. This change in employment subsequently leads to a change in income and hence to a change in consumer demand. Each of these changes sets off a chain reaction which leads to further adjustments in employment output, income, and consumer demand.

In a manner similar to that of Isard and Kuenne, it is then possible to estimate the total employment change by computing a number of successive "rounds" of changes in output, income, consumer spending, and, ultimately, employment.

Review

Reviewed by Miernyk, observations concerning the Moore-Petersen Model are summarized below.

(1) The Moore-Petersen Model is more general than the Isard-Kuenne Model and is designed to provide estimates of total employment effects by industry due to a change in demand for the output of one or more industries in a region.

(2) The Moore-Petersen Model can only be used regionally, and then only if a regional table of coefficients is available.[1]

Comparative Evaluation

It is now necessary to compare both of the above models with the model functions proposed by this researcher. These functions were identified in Chapter I as follows:

(1) Provides an ordered design for the determination of long-range manpower requirements in a municipal organization,

(2) Provides a means of establishing the various interdependencies and interrelationships of those manpower requirements,

(3) Provides a means of estimating total manpower requirement levels,

---

[1] *Ibid.*

(4) Provides a method of analyzing manpower strategies or mixes of strategies in order to predict their impact on the total municipal organization.

The relationship of the Isard-Kuenne and Moore-Petersen Models to this researcher's problem, based on the above functions, may be best illustrated by means of the following table:

TABLE 1

A COMPARATIVE EVALUATION OF THREE MODELS

Functions	Isard-Kuenne Model	Moore-Petersen Model	Author's Model
An ordered design for the determination of long-range manpower requirements in a municipal organization.	NA	NA	A
A means of establishing the various interdependencies and interrelationships of those manpower requirements.	NA	NA	A
A means of estimating total manpower requirement levels.	A	A	A
A method of analyzing manpower strategies or mixes of strategies in order to predict their impact on the total municipal organization.	NA	NA	A

A: Applicable

NA: Non-applicable

This portion of the author's dissertation has reviewed in detail two approaches to manpower planning which were relevant to this researcher's problem. The above table serves to illustrate that, in truth, very little consideration had been given to the development of a basic research method which provides for manpower projection in the municipal form of organization.

Anyone who attempts to determine municipal manpower requirements must explicitly or implicitly employ a projection technique. The municipal organization's need for a quantitative resource for consistent manpower projection stems from its responsibility to develop policies and programs to anticipate emerging problems. Therefore, the question of whether municipal manpower determination should be made was an academic one. The real question was one of how planning decisions involving human resources can be made with a comprehensive understanding of the complexities surrounding such a determination.

CHAPTER V

DEVELOPMENT OF A MODEL FOR THE CONSISTENT DETERMINATION OF MUNICIPAL MANPOWER

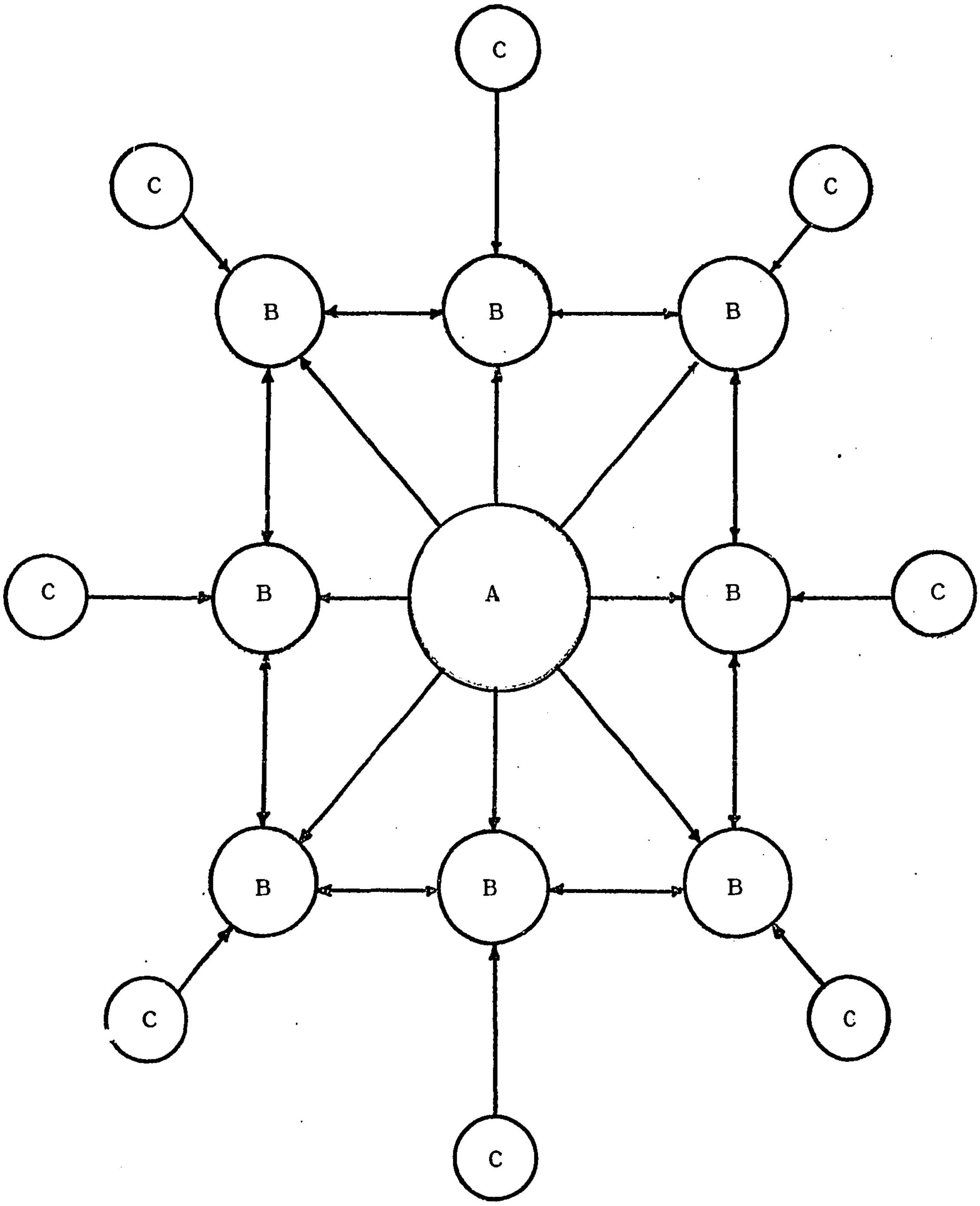
Objectives of the Model

The municipal organization has been technologically characterized as a complex of manpower, each department within the organization drawing directly from this total complex by direct assignment in order to meet the demands placed upon it by the public sector[1] it serves, while at the same time consuming manpower on a continuous basis from other departments within the structure due to the reciprocal nature of the functions concerned.

This chapter provides a mathematical resolution to the circular chain of events as briefly summarized above and as illustrated in Figure 3. The mathematical model as developed in the remainder of this chapter is a representation of a generalized municipal organization. It employs quantitative data which describe the physical flow characteristics of the manpower within the complex and represents those

---

[1] Public sector denotes any convenient geographical subdivision of the municipality in which population exists in varying intensities and is served by the various departments of the municipal organization.



A: Municipal Manpower Requirements
B: Departmental Manpower Requirements
C: Public Sector Manpower Requirements

Fig. 3.--Circular Chaining Effect of Manpower Interaction Within the Municipal Organization.

significant relationships that comprise the municipal organization as an aggregate complex of manpower. Specifically, the model is designed so that manpower within the municipal complex interacts in a manner that replicates their postulated interactions as identified in Chapter I.

Details of the Model

Prior to actually developing the model it is necessary to define those factors which will represent the relationships previously postulated. Primarily, the model as designed works to predict aggregate manpower resource requirements for each department within the organizational complex as a result of the department's primary role, that of servicing the public sector.

Symbolically, the consumption of manpower by these various categories of users within the public sector is denoted in the model as

$$s_{ik} \qquad \begin{array}{l} i=(1,2,\ldots,n) \\ k=(1,2,\ldots,w) \end{array}$$

where s_{ik} represents the amount of equivalent manpower[1]

---

[1] An <u>equivalent man</u> of service is defined as the ratio of the number of hours expended by a department's manpower to service a particular function to that of the accepted municipal accounting standard for that service. For example, the expenditure of 1.5 hours per man-day of service by each member of an eight-man department is equivalent to the expenditure by the subject department of 60 hours per week, assuming a five-day week. With a standard of 40 hours per man-week, it can be shown that the subject department delivers 1.5 equivalent men to the service of this function.

consumed by the k^{th} public sector as supplied by the i^{th} department within the municipal complex. To generalize, by allowing the public sector to be disaggregated into w user-sectors and allowing S_i to represent the total manpower supplied to these sectors by the i^{th} department in a municipal complex consisting of n departments, we have the following equalities:

$$\begin{array}{lcccccccccc}
S_1 & = & s_{11} & + & s_{12} & + & \cdot & \cdot & \cdot & + & s_{1w} \\
S_2 & = & s_{21} & + & s_{22} & + & \cdot & \cdot & \cdot & + & s_{2w} \\
\vdots & & \vdots & & \vdots & & & & & & \vdots \\
S_i & = & s_{i1} & + & s_{i2} & + & \cdot & \cdot & \cdot & + & s_{iw} \\
\vdots & & \vdots & & \vdots & & & & & & \vdots \\
S_n & = & s_{n1} & + & s_{n2} & + & \cdot & \cdot & \cdot & + & s_{nw}
\end{array}$$

This system of equations may be more conveniently represented by

$$S_i = \sum_{k=1}^{w} s_{ik}$$

$$(i=1,2,\ldots,n)$$

At this point it should be noted that the level of disaggregation employed to determine S_i would, of course, be a function of the intended use of the resultant model output. Theoretically, the greater the level of disaggregation, the greater the refinement that could be achieved in the forecasted S_i. However, under practical considerations, the model user has certain prediction objectives and is likely to employ some consolidation procedure to reduce the detail of the model. The basic consideration that must be made by the user concerning aggregation is that of balancing the economy of manipulation against the ease of comprehension.

As previously stated, each department within the municipal complex, as a result of their inherent reciprocal nature, will be called upon to supply on a continuous basis varying degrees of manpower to the other departments within that complex. The magnitude of these indirect requirements is a direct result of the requirements for total manpower indicated by the requesting department. Within the model, the variable

$$r_{ij} \quad (i=1,2,\ldots,n),\ j=(1,2,\ldots n)$$

will represent the magnitude of the intraorganizational consumption of manpower as supplied by the i^{th} $(i=1,2,\ldots,n)$ department of the municipal complex to the j^{th} $(j=1,2,\ldots,n)$ department of that complex.

One special case is worth noting regarding the magnitude of r_{ij}, i.e., when $r_{ij}=0$. This indicates that no interaction is required to sustain the organizational function and this is to be expected in non-related departments.

Thus, as viewed by this model, the municipal organization is in practice a collection of operating departments and the aggregate technological structure is a complex of both direct and indirect manpower requirements. The direct requirements on the disaggregated level were dealt with by the introduction of the variable s_{ik} $(i=1,2,...,n)$, $(k=1,2,...,w)$ and this is represented by S_i $(i=1,2,...,n)$ on the aggregated level. The variable r_{ij} $(i=1,2,...,n)$, $(j=1,2,...,n)$ was introduced to replicate the existence of any indirect manpower consumption. These variables, as defined, follow directly from the functions previously postulated and are physical volume quantities measured in equivalent men. In addition, these linear relationships are considered to hold at any time t_o in the forecast period.

Functionally, the above relationships can be represented by those direct and indirect contributions to the total departmental manpower requirements Z_i $(i=1,2,...,n)$. For the i^{th} department, this relationship states that

Total Departmental Manpower Requirements		Direct Manpower Requirements		Indirect Manpower Requirements

$$Z_i = f \quad S_i \quad \text{plus} \quad \sum_{j=1}^{n} r_{ij}$$

$$i=(1,2,\ldots,n)$$

Development of the Model

Having established by previous research[1] that total municipal staff size Z_T where

$$Z_T = \sum_{i=1}^{n} Z_i$$

is sufficiently linear over time with increasing population, it is reasonable to assume that, at the disaggregated level, Z_T is the sum of likewise sufficiently linear components.

In order to properly generalize an n department municipal complex, the following model was developed:

[1] See Appendix

$$
\begin{array}{ccccccccccc}
Z_1 & = & S_1 & + & r_{11} & + & r_{12} & + & \cdots & + & r_{1n} \\
Z_2 & = & S_2 & + & r_{21} & + & r_{22} & + & \cdots & + & r_{2n} \\
\vdots & & \vdots & & \vdots & & \vdots & & & & \vdots \\
Z_i & = & S_i & + & r_{i1} & + & r_{i2} & + & \cdots & + & r_{in} \\
\vdots & & \vdots & & \vdots & & \vdots & & & & \vdots \\
Z_n & = & S_n & + & r_{n1} & + & r_{n2} & + & \cdots & + & r_{nn}
\end{array}
$$

where, as previously defined

$$
\begin{array}{ccccccccc}
S_1 & = & s_{11} & + & s_{12} & + & \cdots & + & s_{1w} \\
S_2 & = & s_{21} & + & s_{22} & + & \cdots & + & s_{2w} \\
\vdots & & \vdots & & \vdots & & & & \vdots \\
S_i & = & s_{i1} & + & s_{i2} & + & \cdots & + & s_{iw} \\
\vdots & & \vdots & & \vdots & & & & \vdots \\
S_n & = & s_{n1} & + & s_{n2} & + & \cdots & + & s_{nw}
\end{array}
$$

The system of equations presented implicitly relates both direct and indirect manpower requirements for the various Z_i's $(i=1,2,\ldots,n)$. However, it does not explicitly resolve the chaining effect that exists as a result of the interaction of each department's total manpower requirements with all others in the municipal complex. This chaining effect manifests itself in the r_{ij} term of each equation in the system of equations.

As previously defined, r_{ij} represents the magnitude of the indirect manpower as supplied by the i^{th} department within the municipal complex to the j^{th} department where r_{ij} is directly proportional to Z_j and expressed as

$$r_{ij} \propto Z_j$$

To form an equality of the above will require the use of a constant term $\bar{r}_{ij}$ and a proportionality constant m_{ij} where $\bar{r}_{ij}$ represents those manpower usages that are fixed and do not vary over time. The parameter m_{ij} is identified as the marginal manpower coefficient and will represent that proportionality between r_{ij} and Z_j. This equality is formed as

$$r_{ij} = \bar{r}_{ij} + m_{ij}Z_j$$

The basic definition given for r_{ij} previously implied that when $Z_j = 0$, $\bar{r}_{ij}$ must also equal to zero; i.e., there will be no departmental interaction unless there exists a total requirement Z_j and it is this total requirement that completely specifies r_{ij}. Empirically this seems reasonable, for, indeed, if the total requirement Z_j of a department vanishes, it seems logical that interdepartmental support would also cease to exist. This then constrains the above expression to the following:

$$r_{ij} = m_{ij}Z_j$$

Prior to employing the above expression in the original system of equations, it is worthwhile to consider the marginal manpower coefficient as it has been defined. For the purpose of discussion, three factors concerning m_{ij} should be considered. These are as follows:

(1) Historical Nature. The manpower coefficient is by design bound to the historical conditions as they existed at the time they were estimated and represents continuous flows. As was demonstrated, the estimation of the manpower coefficient is one in which r_{ij} strictly represents manpower usages directly related to total manpower requirements as measured by Z_j. If during the time span over which the model is employed the manpower coefficient does not indeed represent continuous flows; i.e., r_{ij} does not exist continuously during the forecast period, then it is quite likely that for the forecast period technological requirements concerning total manpower could be misstated.

(2) Service Mix. Generalizing, it is necessary to recognize that single departments may produce a variety of services. In this case, each department is associated with a primary service and those secondary services as identified by the system of classification employed. In general, the more aggregated the system of classification the fewer secondary services that are explicitly identified. Thus it is that the manpower coefficients are inherently tied to the mix of primary and secondary services even though in a single department the primary service may remain substantially fixed.

(3) Technological Change. In addition to the above, changes in technology occur from time to time which may redefine manpower relationships. The manpower coefficient as defined is bound to the arts practiced at the time of its establishment and represents certain derived demands which could be altered with significant technological advances.

With indirect manpower consumption r_{ij} now recognized as equal to $m_{ij}Z_j$, it is possible to make this substitution in the prior system of equations. Making the substitution yields

$$
\begin{array}{ccccccccc}
Z_1 & = & S_1 & + & m_{11}Z_1 & + & m_{12}Z_2 & + \cdot \cdot \cdot + & m_{1n}Z_n \\
Z_2 & = & S_2 & + & m_{21}Z_1 & + & m_{22}Z_2 & + \cdot \cdot \cdot + & m_{2n}Z_n \\
\vdots & & \vdots & & \vdots & & \vdots & & \vdots \\
Z_i & = & S_i & + & m_{i1}Z_1 & + & m_{i2}Z_2 & + \cdot \cdot \cdot + & m_{in}Z_n \\
\vdots & & \vdots & & \vdots & & \vdots & & \vdots \\
Z_n & = & S_n & + & m_{n1}Z_1 & + & m_{n2}Z_2 & + \cdot \cdot \cdot + & m_{nn}Z_n
\end{array}
$$

where $S_1, S_2, \ldots, S_i, \ldots, S_n$ are as previously defined.

Transformation of the above system into the following format facilitates the use of matrix notation. This transformation is indicated as follows:

$$
\begin{array}{ccccccccc}
Z_1 & - & m_{11}Z_1 & - & m_{12}Z_2 & - \cdot \cdot \cdot - & m_{1n}Z_n & = & S_1 \\
Z_2 & - & m_{21}Z_1 & - & m_{22}Z_2 & - \cdot \cdot \cdot - & m_{2n}Z_n & = & S_2 \\
\vdots & & \vdots & & \vdots & & \vdots & & \vdots \\
Z_i & - & m_{i1}Z_1 & - & m_{i2}Z_2 & - \cdot \cdot \cdot - & m_{in}Z_n & = & S_i \\
\vdots & & \vdots & & \vdots & & \vdots & & \vdots \\
Z_n & - & m_{n1}Z_1 & - & m_{n2}Z_2 & - \cdot \cdot \cdot - & m_{nn}Z_n & = & S_n
\end{array}
$$

Formulating the above system of equations in matrix notation with a square matrix identified by the general form

$$\overset{*}{A} = \begin{bmatrix} a_{11} & \cdots & a_{1j} & \cdots & a_{1n} \\ \vdots & & \vdots & & \vdots \\ a_{i1} & \cdots & a_{ij} & \cdots & a_{in} \\ \vdots & & \vdots & & \vdots \\ a_{n1} & \cdots & a_{nj} & \cdots & a_{nn} \end{bmatrix}$$

yields

$$\begin{bmatrix} 1-m_{11}, & -m_{12}, & - \cdots, & -m_{1n} \\ -m_{21}, & 1-m_{22}, & - \cdots, & -m_{2n} \\ \vdots & \vdots & & \vdots \\ -m_{i1}, & -m_{i2}, & - \cdots, & -m_{in} \\ \vdots & \vdots & & \vdots \\ -m_{n1}, & -m_{n2}, & - \cdots, & 1-m_{nn} \end{bmatrix} \cdot \begin{bmatrix} Z_1 \\ Z_2 \\ \vdots \\ Z_i \\ \vdots \\ Z_n \end{bmatrix} = \begin{bmatrix} S_1 \\ S_2 \\ \vdots \\ S_i \\ \vdots \\ S_n \end{bmatrix}$$

The entire system of equations is now expressed in matrix notation and is composed of a square matrix and two column vectors. To further simplify notation, allow

$$\overset{*}{M} = \begin{bmatrix} m_{11}, & m_{12}, & \cdots, & m_{1n} \\ m_{21}, & m_{22}, & \cdots, & m_{2n} \\ \vdots & \vdots & & \vdots \\ m_{i1}, & m_{i2}, & \cdots, & m_{in} \\ \vdots & \vdots & & \vdots \\ m_{n1}, & m_{n2}, & \cdots, & m_{nn} \end{bmatrix}$$

and

$$\overset{*}{Z} = \begin{bmatrix} Z_1 \\ Z_2 \\ \vdots \\ Z_i \\ \vdots \\ Z_n \end{bmatrix} \qquad \overset{*}{S} = \begin{bmatrix} S_1 \\ S_2 \\ \vdots \\ S_i \\ \vdots \\ S_n \end{bmatrix}$$

Under the matrix notation, the system of equations can be conveniently written as

$$\overset{*}{Z} - \overset{*}{M}\overset{*}{Z} = \overset{*}{S} .$$

In order to carry out the indicated subtraction implied by the prior matrix equation, it is necessary to employ a fundamental definition of matrix algebra. Allowing I to be defined as the identity matrix, i.e.,

$$I = \begin{bmatrix} 1 & 0 & . & . & . & 0 \\ 0 & 1 & . & . & . & 0 \\ . & . & & & & . \\ . & . & & & & . \\ . & . & & & & . \\ . & . & & & & . \\ 0 & 0 & . & 1 & . & 0 \\ . & . & & & & . \\ . & . & & & & . \\ . & . & & & & . \\ . & . & & & & . \\ 0 & 0 & . & . & . & 1 \end{bmatrix}$$

it can be shown that

$$I\overset{*}{Z} = \overset{*}{Z} .$$

This substitution yields the following:

$$I\overset{*}{Z} - \overset{*}{M}\overset{*}{Z} = \overset{*}{S}$$

or

$$(I - \overset{*}{M})\, \overset{*}{Z} = \overset{*}{S} .$$

It should be observed that the resultant matrix expression represents a system of equations in three variables. The public policy administrator is ostensively interested in total departmental manpower resource requirements and it consequently becomes meaningful to develop the previous expression in such a way that Z_i $(i=1,2,\ldots,n)$ may be determined. By employing the concept of the inverse matrix it is possible to resolve the previous matrix expression for total departmental manpower requirements Z_i $(i=1,2,\ldots,n)$. By definition, the inverse of $\overset{*}{M}$ (identified as $\overset{*}{M}^{-1}$) is defined as that matrix which when multiplied by $\overset{*}{M}$ yields the identity matrix I ; i.e., $\overset{*}{M}\overset{*}{M}^{-1}=I$. Left multiplying by $(I-\overset{*}{M})^{-1}$ in the latter equation yields

$$\overset{*}{Z} = (I-\overset{*}{M})^{-1}\overset{*}{S}$$

where $(I-\overset{*}{M})^{-1}$ is defined as the inverse of $(I-\overset{*}{M})$.

In order to avoid confusion, we shall identify the elements of the inverse matrix $(I-\overset{*}{M})^{-1}$ as x_{ij} and the inverse itself by $\overset{*}{X}$, i.e.,

$$\overset{*}{X} = \begin{bmatrix} x_{11}, & x_{12}, & \ldots, & x_{1n} \\ x_{21}, & x_{22}, & \ldots, & x_{2n} \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ x_{i1}, & x_{i2}, & \ldots, & x_{in} \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ x_{n1}, & x_{n2}, & \ldots, & x_{nn} \end{bmatrix}$$

With this definition of $\overset{*}{X}$, an algorithm representing both direct and indirect manpower requirements within the municipal complex has been developed.

Having established $\overset{*}{X}$, it is now necessary to develop a systems expression for interdepartmental manpower transactions which would reflect a projected level of demand within the public sector. As was previously established, municipal manpower is significantly consumed by differing sectors of the municipality in varying degrees. Projected demand inputs are a result of this differentiation which reflects both the inherent sensitivity to the constantly changing trends in population congestion and the changing demands for additional manpower made by the public sector to modify the current standard of living.

Designate a projected public sector demand vector by $S_{i(p)}$ on the aggregated level and $s_{ik(p)}$ on the disaggregated level. Forming a product of $\overset{*}{X}$ and the projected public sector column vector, the latter composed of the elements $S_{i(p)}$ for $(i=1,2,...,n)$, yields

$$\begin{bmatrix} x_{11}, & x_{12}, & \cdots, & x_{1n} \\ x_{21}, & x_{22}, & \cdots, & x_{2n} \\ \vdots & \vdots & & \vdots \\ x_{i1}, & x_{i2}, & \cdots, & x_{in} \\ \vdots & \vdots & & \vdots \\ x_{n1}, & x_{n2}, & \cdots, & x_{nn} \end{bmatrix} \cdot \begin{bmatrix} S_{1(p)} \\ S_{2(p)} \\ \vdots \\ S_{i(p)} \\ \vdots \\ S_{n(p)} \end{bmatrix} =$$

$$\begin{bmatrix} x_{11}S_{1(p)} + x_{12}S_{2(p)} + \cdots + x_{1n}S_{n(p)} \\ x_{21}S_{1(p)} + x_{22}S_{2(p)} + \cdots + x_{2n}S_{n(p)} \\ \vdots \qquad\qquad \vdots \qquad\qquad \vdots \\ x_{i1}S_{1(p)} + x_{i2}S_{2(p)} + \cdots + x_{in}S_{n(p)} \\ \vdots \qquad\qquad \vdots \qquad\qquad \vdots \\ x_{n1}S_{1(p)} + x_{n2}S_{2(p)} + \cdots + x_{nn}S_{n(p)} \end{bmatrix}$$

Each row of the above matrix, i.e.,

$$\sum_{i=1}^{n} x_{ij}S_{j(p)} \qquad (j=1,2,\ldots,n)$$

yields a projected total departmental manpower requirement $Z_{i(p)}$. Forming a column vector of the resultant $Z_{i(p)}$'s and multiplying each row element of the direct manpower coefficient matrix by this column vector yields

$$\begin{bmatrix} m_{11}, & m_{12}, & \cdots, & m_{1n} \\ m_{21}, & m_{22}, & \cdots, & m_{2n} \\ \vdots & \vdots & & \vdots \\ m_{i1}, & m_{i2}, & \cdots, & m_{in} \\ \vdots & \vdots & & \vdots \\ m_{n1}, & m_{n2}, & \cdots, & m_{nn} \end{bmatrix} \cdot \begin{bmatrix} Z_{1(p)} \\ Z_{2(p)} \\ \\ Z_{i(p)} \\ \\ Z_{n(p)} \end{bmatrix} =$$

$$\begin{bmatrix} m_{11}Z_{1(p)} + m_{12}Z_{2(p)} + \cdots + m_{1n}Z_{n(p)} \\ m_{21}Z_{1(p)} + m_{22}Z_{2(p)} + \cdots + m_{2n}Z_{n(p)} \\ \vdots \\ m_{i1}Z_{1(p)} + m_{i2}Z_{2(p)} + \cdots + m_{in}Z_{n(p)} \\ \vdots \\ m_{n1}Z_{1(p)} + m_{n2}Z_{2(p)} + \cdots + m_{nn}Z_{n(p)} \end{bmatrix}$$

In order to retain consistent notation, we shall identify the elements of the above matrix as $r_{ij(p)}$ and the matrix itself as $\overset{*}{R}$. This, as a result, becomes

$$\overset{*}{R} = \begin{bmatrix} r_{11(p)} + r_{12(p)} + \cdots + r_{1n(p)} \\ r_{21(p)} + r_{22(p)} + \cdots + r_{2n(p)} \\ \vdots \\ r_{i1(p)} + r_{i2(p)} + \cdots + r_{in(p)} \\ \vdots \\ r_{n1(p)} + r_{n2(p)} + \cdots + r_{nn(p)} \end{bmatrix}$$

The elements of the sum in each row thus represent those interdepartmental transactions required to sustain the forecasted public sector demands, $S_{i(p)}$ for $i=1,2,\ldots,n$.

A Numerical Exposition of the Model

With the use of a numerical example, this section is devoted to an elaboration of the mathematical algorithm previously developed. To aid this exposition, a hypothetical municipal organization was devised which consists of six departments. In addition, five public sectors were identified and it was established that manpower allocation to each of these sectors by the various departments within the municipal complex was currently distributed as shown in Table 2.

TABLE 2

CURRENT DISTRIBUTION OF DEPARTMENTAL MANPOWER (s_{ik}) WITHIN THE PUBLIC SECTORS OF A HYPOTHETICAL MUNICIPAL ORGANIZATION

Department Number	Public Sector Number					$\sum s_{ik}$
	1	2	3	4	5	
1	2	5	1	3	13	24
2	1	6	3	4	15	29
3	2	3	1	3	4	13
4	1	0	1	2	3	7
5	1	2	1	3	7	14
6	2	4	2	1	7	16

Similarly, interdepartmental consumption of manpower within the organizational complex was currently established to be that shown in Table 3.

TABLE 3

CURRENT INTERDEPARTMENTAL CONSUMPTION OF MANPOWER WITHIN A HYPOTHETICAL MUNICIPAL ORGANIZATION (r_{ij})

Department Number	1	2	3	4	5	6
1	10	15	1	2	5	6
2	5	4	7	1	3	8
3	7	2	8	1	5	3
4	11	1	2	8	6	4
5	4	0	1	14	3	2
6	2	6	7	6	2	6

Having established current manpower allocation within both the municipal complex and the public sector, total manpower was derived by summing rows of Tables 2 and 3, respectively, and adding to obtain the resultant summations which are presented in Table 4.

TABLE 4

CURRENT TOTAL DEPARTMENTAL MANPOWER REQUIREMENTS FOR A HYPOTHETICAL MUNICIPAL ORGANIZATION (Z_i)

Department Number	Z_i
1	63
2	57
3	39
4	39
5	38
6	45

With Table 4 established, it remains now to compute the marginal manpower coefficient as defined in a prior section of this chapter. Computationally, this consists of dividing all the entries in each department column of Table 3 by the total current demand for that department as shown by Table 4. For example, the current total demand made by Department 1 on the gross manpower of the municipal complex was established at 63. To compute the coefficients of Table 3, column 1, requires that each entry in that column be divided by 63. A similar procedure which was followed for all other columns of Table 3 resulted in the following computations of direct manpower usages. These computations are presented in Table 5.

TABLE 5

CURRENT DIRECT MANPOWER USAGES ($\overset{*}{M}$) WITHIN A HYPOTHETICAL MUNICIPAL ORGANIZATION

Department Number	1	2	3	4	5	6
1	.16	.26	.03	.05	.13	.13
2	.08	.07	.18	.03	.08	.18
3	.11	.04	.21	.03	.13	.07
4	.17	.02	.05	.21	.16	.09
5	.06	0	.03	.36	.08	.04
6	.03	.11	.18	.15	.05	.13

By reading down the columns of Table 5, each cell within a column indicates the amount of direct support that will be required by that department column from the row departments indicated at the left of the table. For example, direct manpower support for Department 2, expressed in equivalent men, is shown by Table 5 to be:

Department Number	Direct Manpower Support For Department 2
1	0.26
3	0.04
4	0.02
5	0
6	0.11

Hence, Table 5 indicates the direct manpower support that is required by a given department in the municipal complex from all other departments within that complex for the delivery of one equivalent man of service to the public sector.

However, this does not represent the total addition to manpower required, for, as previously noted, an increase in the demands for manpower by the public sector has direct as well as indirect effects. Assume the delivery to the public sector of one equivalent man of service by each department in the municipal complex. As a result of the model development, the calculation of the total expansion of manpower, both direct and indirect within the municipal complex requires taking the difference between the identity matrix and the marginal manpower coefficient matrix, the latter as developed in Table 5, and then computing the inverse. The final results of this effort are shown in Table 6.

With Table 6 developed, the model user is now in a position to make a total interdepartmental manpower projection as a result of changes in the elements of the public sector demand vector. In making an actual forecast, each of the public sector demand elements would be projected independently. By department, these individual projections would be summed to form an element in the public demand column vector. Assume these projections to be as shown below in Table 7. Note that in the hypothetical projections of public sector demands most departments within the municipal complex expect an increase. However, Departments 2 and 5 have been deliberately shown to decline in order to illustrate what will happen to the total manpower projection when some departments expect an expansion of manpower while other departments expect a decline.

With individual public sector demand rates projected and developed into a column vector, it is now possible to make projections for total interdepartmental manpower requirements. The computational procedure for projecting total interdepartmental manpower requirements is as follows:

(1) Multiply each row vector of direct and indirect coefficients (Table 6) by the projected public sector demand column vector. The result will be a table the dimensions of Table 6.

TABLE 6

CURRENT DIRECT AND INDIRECT MANPOWER REQUIREMENTS $(I-\overset{*}{M})^{-1}$
RESULTING FROM PUBLIC SECTOR DEMANDS FOR
ONE EQUIVALENT MAN OF SERVICE

Department Number	1	2	3	4	5	6
1	1.38	.25	.28	.41	.27	.23
2	.45	1.21	.16	.19	.12	.24
3	.27	.38	1.38	.23	.17	.39
4	.35	.25	.25	1.53	.65	.41
5	.35	.26	.31	.39	1.28	.25
6	.38	.35	.22	.30	.21	1.32

TABLE 7

PROJECTED DISTRIBUTION OF DEPARTMENTAL MANPOWER $(s_{ik(p)})$
WITHIN THE PUBLIC SECTORS OF A HYPOTHETICAL
MUNICIPAL ORGANIZATION

Department Number	Public Sector Number					$\sum s_{ik(p)}$ Projected	$\sum s_{ik}$ Original
	1	2	3	4	5		
1	3	5	3	5	14	30	24
2	1	6	3	4	12	26	29
3	3	3	2	4	5	17	13
4	1	3	1	3	2	10	7
5	1	2	1	3	6	13	14
6	2	4	2	4	8	20	16

(2) Sum each row of the table obtained in step 1. Transfer the column vector that is obtained by this summation to the right of Table 5, the table representing direct coefficients.

(3) Multiply each row vector in the table of direct coefficients (Table 5) by the column vector at the right of this table. The ultimate result will be a table giving total projected interdepartmental manpower requirements.

Based on the assumed changes in the public sector as given by Table 7 and employing the assumption that for the projection period the marginal manpower coefficients are sufficiently constant, the interdepartmental projection below was made. The projected interdepartmental manpower requirements are shown in the upper portion of each cell of Table 8. The figures in parentheses in the lower portion of the cells are the current values of interdepartmental requirements as shown by Table 3.

TABLE 8

PROJECTED INTERDEPARTMENTAL CONSUMPTION OF MANPOWER $(r_{ij(p)})$
WITHIN A HYPOTHETICAL MUNICIPAL ORGANIZATION

Dept. No.	1	2	3	4	5	6
1	11.73 (10)	15.49 (15)	1.22 (1)	2.46 (2)	5.79 (5)	7.20 (6)
2	05.87 (5)	04.13 (4)	8.56 (7)	1.23 (1)	3.47 (3)	9.60 (8)
3	08.21 (7)	02.07 (2)	9.78 (8)	1.23 (1)	5.79 (5)	3.60 (3)
4	12.90 (11)	01.04 (1)	2.45 (2)	9.84 (8)	6.95 (6)	4.79 (4)
5	04.69 (4)	0 (0)	1.22 (1)	17.22 (14)	3.48 (3)	2.40 (2)
6	02.35 (2)	06.20 (6)	8.56 (7)	7.38 (6)	2.32 (2)	7.19 (6)

Although the public sector demands for the manpower of Departments 2 and 5 declined, the values of their interdepartmental transactions increased. The increases, however, are smaller than those for the departments which projected increases in demands for their manpower in the public sector. Notice that in the hypothetical example the increases in interdepartmental requirements for Department 2 offset the projected drop in demands for manpower in the public sector so that the total demand for municipal manpower in this department was projected to increase. In the case of Department 5, increases in interdepartmental transactions more than offset the projected decline in demand for manpower by the public sector with total demand for gross municipal manpower rising. As would be expected, there are larger relative gains in total demand for municipal manpower from those departments that were projected to increase in both the public sector demand and interdepartmental transactions.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

This dissertation has demonstrated that the question of consistent manpower projection in the municipal organization can be meaningfully formulated. Basically, this formulation provides an ordered design for the determination of long-range manpower requirements in a municipal complex. In addition, the design of this conceptual framework offers the public policy administrator a quantitative resource that can provide the visibility necessary to develop a meaningful estimate of manpower levels in considerable detail.

Specifically, the model can be utilized to project municipal employment levels for various levels of service in the public sector. Public policy administrators can also use this quantitative resource in preparing budgetary proposals, for they are now in a position to build up a more accurate total manpower estimate for the various functions of the municipal complex. Municipal middle management usually has a reasonably good understanding of the population trends as they exist in the public sector it serves. Given an accurate forecast of the demands in the public sector, this line management, with the aid of the quantitative resource formulated, is also in an excellent position to act to adjust manpower resource allocation to the projected facts. Thus, consistent forecasting of the type developed here should prove invaluable not only to chief administrators but to all of management.

Although the model developed has succeeded in providing a means of establishing the various interdependencies and interrelationships of manpower requirements within the total municipal complex, this does not guarantee, of course, that consistent forecasting will of necessity be correct. This method of forecasting does provide that the manpower requirements of each function within the municipal complex are consistent with the demands from both the public sector and other departments within the complex. Even if there are errors in the projections, however, the results should still prove useful to those charged with the administration of the municipal organization by providing guidelines to those who must inevitably meet changes and challenges in the decades ahead.

If the model did nothing more than describe structural interdependence, it would be a useful analytical resource for the public policy administrator. However, it can do much more: A series of consistent forecasts over time, for example, can be used in making a detailed comparative analysis of the relative growth patterns of the organizational manpower structure. The model could also be employed by the public policy administrator to assist in determining types of manpower investments that will be required with time. In addition, it provides a method of forecasting that is basic to sensitivity analysis as well as feasibility testing, the objectives of which are to determine those elements of the municipal manpower structure most sensitive to alternate patterns of demand by the public sector.

By providing a method of analyzing manpower strategies or mixes of strategies in order to predict their impact on the total municipal complex, questions regarding the feasibility of reaching a specific employment target could be motivated. What will this involve regarding the public sector as well as interdepartmental usages? What bottlenecks, if any, are likely to be encountered as a result of changing congestion patterns? In analyzing these and other problems, additional questions will be raised.

As the author views the scope suggested by this research, it appears that the most logical consideration for further extension is that of an effective solution to the problem of classification of personnel.

It is well documented that the budgetary requirements of the municipal complex have continuously risen over the past years. Disregarding the nuances responsible for this rise, the public policy administrator is currently faced with ever-mounting pressures to increase the quantity and quality of service while performing this expanded function with the same personnel expenditures he currently exhibits. Thus, in addition to being able to adequately forecast his manpower requirements, the administrator will require, as never before, a method to assure himself that positions are staffed in the most intelligent manner possible.

Within the established framework of this dissertation it seems timely, therefore, to do research into the problem of classification of personnel to see what the concept means, what issues it raises with respect to the theory of management, and what problems it presents with respect to the practical operation of the municipal organization. Possibly the most definitive work to date concerning the total concept of personnel classification is that of Thorndike.[1] In the context of his discussion he states that in the case of the problem of personnel classification within the organization, "no mathematically best solution has been formulated."[2] Preliminary research by this author has revealed no significant work to the contrary.

Thorndike expresses a somewhat pessimistic view when he further states, "It is, of course, possible that no solution exists."[3]

---

[1]Robert L. Thorndike, "The Problem of Classification of Personnel," <u>Psychometrika</u>, XV (September, 1950), 215-235.

[2]<u>Ibid</u>., p. 217.

[3]<u>Ibid</u>.

APPENDIX

APPENDIX A

THE ASCERTAINING OF LINEARITY

THE ASCERTAINING OF LINEARITY[1]

Formulation of the Problem

The primary objective of this appendix is that of answering the central question:

> To what extent may it be assumed that a linear relationship exists between the relative size of a municipal organization and the population it serves?

That is to say, does the totality of the municipal organization's size increase in a linear manner with increasing population, all other factors being constant?

Formulation of the Experiment

It was reasoned by this investigator that if for numerous population sizes, corresponding municipal staff levels could be obtained and if this data represented a sufficient span of time, then it would be possible to test such a sample of data in order to resolve this question of linearity. To this end, the researcher selected the following population sizes for which data were collected:

---

[1]David Gordon, The Ascertaining of Linearity, Doctoral Research Report Series of the School of Industrial Engineering of the University of Oklahoma, I-69 (Norman, Oklahoma, April 15, 1969).

POPULATION SIZE		TOLERANCE
50,000	±	5%
75,000	"	5%
100,000	"	5%
150,000	"	5%
200,000	"	5%
250,000	"	5%
300,000	"	5%
350,000	"	5%
400,000	"	5%
450,000	"	5%
500,000	"	5%

For each year in the 1955 through 1965[1] time span and for each of the population categories shown above, ten (10) municipalities which met the population constraint were randomly[2] selected from the Municipal Year Book[3] of that year. For each such selection that was made, the corresponding municipal staffing level for that year was recorded. This resulted in the gathering of one hundred (100) independent samples for each population category, providing a

---

[1]Source data for 1958 were presented in a format inappropriate for use in this study. No explanation was given for the change.

[2]Acheson J. Duncan, Quality Control and Industrial Statistics (Homewood, Illinois: Richard D. Irwin, Inc., 1965), p. 938.

[3]Municipal Year Book, The, 1956, 1957, 1958, 1960, 1962, 1963, 1964, 1965, 1966 (Chicago: The International City Managers' Association).

total of eleven hundred (1100) independent samples which constitute the entire sample data base. A representative sample of these data is presented in Table 1.

Rank Test

Prior to ascertaining whether linearity existed, it was necessary to establish whether or not it could be reasonably hypothesized that for a given population category the mean values of the municipal organization sizes recorded for the various years were, in effect, the same. A non-parametric Rank Test that was appropriately suited for the determination of such a hypothesis concerning the equality of means of independent samples is presented by Bowker and Lieberman in their statistics text[1] and was employed by this researcher.

Each primary data base was subjected to three (3) separate but identical Rank Tests with the format of these tests as follows:

> Rank Test 1--The years 1955-1960 were considered as Set 1; the years 1961-1965 were considered as Set 2. Ten (10) samples were randomly selected from both sets and the Rank Test applied to the resulting twenty (20)-sample subset.
>
> Rank Test 2--The year 1955 was considered as Set 1; the year 1965 was considered as Set 2. The Rank Test was applied to the resulting twenty (20) - sample subset.

---

[1]Albert H. Bowker and Gerald J. Lieberman, Engineering Statistics (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1959), p. 184.

TABLE 1

RANDOMLY SELECTED SAMPLES OF MUNICIPAL STAFF SIZES COMPRISING A PRIMARY DATA BASE FOR MUNICIPALITIES OF 50,000 ± 5% POPULATION

YEAR				
1955	1956	1957	1959	1960
351	1197	374	765	540
236	1057	339	934	1026
1020	312	566	371	764
1006	539	827	620	408
334	439	501	680	340
499	266	450	250	647
256	788	438	917	592
417	619	339	538	480
734	324	833	335	1261
546	360	1213	370	926

YEAR				
1961	1962	1963	1964	1965
532	954	480	784	482
967	207	531	816	503
212	533	738	909	981
977	813	499	556	274
745	343	871	986	426
416	372	818	329	272
467	439	623	391	622
343	744	548	472	285
792	969	1214	591	226
515	480	989	471	1062

Rank Test 3--The year 1957 was considered as Set 1; the year 1963 was considered as Set 2. The Rank Test was applied to the resulting twenty (20) - sample subset.

If there is no difference between sets in each individual Rank Test, it would be expected that they would intermingle in a regular way and, if they are both of the same size, it would be expected that the sum of ranks would be about the same for both.[1] In this case, the null hypothesis, H_o, was established as follows:

H_o -- the mean of Set 1 = the mean of Set 2 for each individual test.

The alternate hypothesis H_1 was established as follows:

H_1 -- the mean of Set 1 $\neq$ the mean of Set 2 for each individual test.

The probability of committing a Type 1 Error was established at 1%, i.e., $\alpha = 0.01$. Sample sizes for both Set 1 and Set 2 were established at ten (10) each and designated by n_1 and n_2, respectively.

Once the sub-samples had been ranked, it remained for each of the thirty-three (33) separate tests to determine whether a significant difference regarding the equality of means did exist at the 1% level of significance. This was accomplished for each test by entering Table 7.6 (p. 186 of Bowker and Lieberman) with

---

[1] Ibid.

$$R_1 = \text{sum of the ranks of the smaller sample}$$

and $$R_1' = n_1 (n_1 + n_2 + 1) - R_1$$

and rejecting if either R_1 or R_1' was less than the tabled critical value which was equal to 71. The results of the thirty-three (33) independent Rank Tests are summarized in Tables 2, 3, and 4 that follow.

It was concluded that after computing the values of the statistical test using the data obtained from the samples, no significant departures exist at the 1% point and, hence, the decision to accept H_o at this chosen level of significance can be made. Acceptance of H_o constitutes the assertion that H_1 is rejected.

F Test

As revealed by the representative primary sample data base, this experiment was performed so that for each value of x (population size) there existed k values of y (municipal staff size). To test linearity in this case, it became necessary to employ the procedure recommended by Bowker and Lieberman[1] for such an experimental design. Bowker and Lieberman state that the hypothesis of linearity may be rejected if

---

[1] Ibid., p. 260.

TABLE 2

RANK TEST SUMMARY, TEST 1

Population (1000)	Set 1 Years	Set 2 Years	R_1	R_1'	Critical Value @ α =0.01	Accept H_o Reject H_1
50	1955-60	1961-65	98	112	71	A
75	↓	↓	104	106	↓	A
100			96	114		A
150			104	106		A
200			90	120		A
250			99	111		A
300			104	106		A
350			97	113		A
400			97	113		A
450			86	124		A
500	1955-60	1961-65	93	117	71	A

A: Acceptance

TABLE 3

RANK TEST SUMMARY, TEST 2

Population (1000)	Set 1 Year	Set 2 Year	R_1	R_1'	Critical Value @ α =0.01	Accept H_o Reject H_1
50	1955	1965	102	108	71	A
75			93	117		A
100			94	116		A
150			96	114		A
200			101	109		A
250			105	105		A
300			97	113		A
350			90	120		A
400			104	106		A
450			87	123		A
500	1955	1965	103	107	71	A

A: Acceptance

TABLE 4

RANK TEST SUMMARY, TEST 3

Population (1000)	Set 1 Year	Set 2 Year	R_1	R_1'	Critical Value @ α =0.01	Accept H_o Reject H_1
50	1957	1963	102	108	71	A
75			93	117		A
100			101	109		A
150			100	110		A
200			105	105		A
250			97	113		A
300			100	110		A
350			88	122		A
400			91	119		A
450			100	110		A
500	1957	1963	99	111	71	A

A: Acceptance

$$F = \frac{k\sum_{i=1}^{n}(\overline{Y}_i - \tilde{Y}_i)^2/(n-2)}{\sum_{i=1}^{n}\sum_{\nu=1}^{k}(Y_{i\nu} - \overline{Y}_i)^2/n(k-1)} \geqq F_{\alpha\,;\,n-2,\,n(k-1)}$$

where values of $F_{\alpha;\, n-2,\, n(k-1)}$, the 100 α percentage point of the F distribution with $\nu_1 = n-2$ and $\nu_2 = n(k-1)$ degrees of freedom are given by Appendix Table 4 of Bowker and Lieberman (pp. 564-568).

This test is reasonable in that it compares the variability about the fitted line (numerator) with the inherent variability of the y's which is independent of the form of the relationship (denominator). If linearity exists, these variabilities should compare favorably.[2]

The experimental procedure for the F test was established as follows:

1) The null hypothesis, H_o, was stated as:

   H_o--linearity <u>does</u> exist.

2) The alternate hypothesis, H_1, was stated as:

   H_1--linearity <u>does not</u> exist.

3) Let α = 0.01 with n=11 and k=5

4) The critical value was found by entering Appendix Table 4 (p.564) of Bowker and Lieberman. This value was determined to be 2.84.

---

[2] Ibid.

Since the Rank Test established the homogeneity of means for each of the primary data bases, it was possible to randomly select from each of the primary data bases five (5) independent municipal staff sizes and to use this sub-set in the evaluation of the F test. The results of this random sampling are depicted by Table 5.

TABLE 5

RANDOM SAMPLE FOR F TEST

Population (1000) X_i	$\bar{x}=\sum_{i=1}^{11} X_i/_{11}$	Random Sample Y_i	$\bar{Y}_i=\sum_{i=1}^{5} Y_i/_5$	$\bar{\bar{Y}}=\sum_{i=1}^{11} \bar{Y}_i/_{11}$
50		788		
		917		
		417		
		532		
		370	604.8	
75		725		
		680		
		845		
		749		
		572	714.2	
100		1197		
		1356		
		986		
		1096		
		977	1123.0	
150		2302		
		1709		
		1934		
		1992		
		2228	2033.0	
200		2567		
		2653		
		2866		
		2220		
		2045	2470.2	

TABLE 5--Continued

Population (1000) X_i	$\bar{x}=\sum_{i=1}^{11} X_i/_{11}$	Random Sample Y_i	$\bar{Y}_i=\sum_{i=1}^{5} \bar{Y}_i/_5$	$\bar{\bar{Y}}=\sum_{i=1}^{11} \bar{Y}_i/_{11}$
250		3271		
		2914		
		3143		
		3355		
		3107	3158.0	
300		4079		
		3941		
		4140		
		3770		
		3726	3931.2	
350		4749		
		4942		
		4660		
		4627		
		4849	4765.4	
400		5532		
		5349		
		5826		
		4988		
		5472	5433.4	
450		5654		
		5976		
		5793		
		6109		
		5700	5846.4	
500		7300		
		6661		
		6542		
		7129		
	256.8	7242		3368.6

With the statistical procedure firmly established and the random sampling from each primary data base complete, it remained then to compute the value of the F expression given by Bowker and Lieberman and to compare this value with the critical value so that a decision concerning linearity could be made. A summary of this effort follows.

The model presented by Bowker and Lieberman has the property that the average value of the random variable y can be expressed as a linear function of a known variate x, i.e.,

$$E(y) = A + Bx$$

The values of A and B were unknown and were estimated using the data gathered. The estimates of A and B were denoted by a and b, respectively. Thus, the estimated relationship was of the form

$$\tilde{y} = a + bx$$

Bowker and Lieberman give the following for the evaluation of these estimators:

$$b = \frac{\sum_{i=1}^{n} (X_i - \overline{X})(Y_i - \overline{\overline{Y}})}{\sum_{i=1}^{n} (X_i - \overline{X})^2}$$

$$a = \overline{\overline{Y}} - bx$$

where $\overline{\overline{y}}$ was previously evaluated in Table 5.

TABLE 6

EVALUATION OF THE A AND B ESTIMATORS

X_i	$X_i-\overline{X}$	$(X_i-\overline{X})^2$	$\overline{Y}_i$	$Y_i-\overline{\overline{Y}}$	$(X_i-\overline{X})\ (Y_i-\overline{\overline{Y}})$
50	-206.8	42766	604.8	-2.7638	571.6
75	-181.8	33051	714.2	-2.6544	482.6
100	-156.8	24586	1123.0	-2.2456	352.1
150	-106.8	11406	2033.0	-1.3356	142.6
200	- 56.8	3226	2470.2	-0.8984	51.0
250	- 6.8	46	3158.0	-0.2106	1.4
300	43.2	1866	3931.2	0.5626	24.3
350	93.2	8686	4765.4	1.3968	130.2
400	143.2	20506	5433.4	2.0648	295.7
450	193.2	37326	5846.4	2.4778	478.7
500	243.2	59146	6974.8	3.6062	877.0

$$\sum_{i=1}^{11} (X_i-\overline{X})(Y_i-\overline{\overline{Y}}) = 3407.2$$

$$\sum_{i=1}^{11} (X_i-\overline{X})^2 = 242{,}611$$

$$b = 3407.2 \ / \ 242611 = 0.014$$

$$a = 3.3638 - 0.014\ (256.8)\ (10^3)$$

$$a = -226.6$$

With the values of a and b determined, the fitted line $\tilde{y} = a + bx$, was evaluated for the various values of x. This evaluation is shown below:

TABLE 7

EVALUATION OF THE FITTED LINE

X_i	$0.014\ X_i$	$\tilde{Y}_i = 0.014\ X_i - 226.6$
50	700	473.4
75	1050	823.4
100	1400	1173.4
150	2100	1873.4
200	2800	2573.4
250	3500	3273.4
300	4200	3973.4
350	4900	4673.4
400	5600	5373.4
450	6300	6073.4
500	7000	6774.4

It was then possible to evaluate the F expression given by Bowker and Lieberman. As previously presented, this expression was:

$$F = \frac{k \sum_{i=1}^{n} (\overline{Y}_i - \tilde{Y}_i)^2/(n-2)}{\sum_{i=1}^{n} \sum_{\nu=1}^{k} (Y_{i\nu} - \overline{Y}_i)^2/n(k-1)}$$

The above model was most efficiently evaluated by developing results for the numerator and denominator independently and then performing the indicated division. Tables 8 and 9 are a detailed summary of this effort.

Summing column 6 of Table 9, it was determined that

$$\sum_{i=1}^{n} \sum_{\nu=1}^{k} (Y_{i\nu} - \overline{Y}_i)^2 / n(k - 1) = 44533 \ .$$

Performing the indicated division using the appropriately determined values, the F was found to be equal to

$$F = \frac{104887}{44533} = 2.35 \ .$$

Because the calculated value of 2.35 is less than the tabled critical value previously found to be 2.84, it was concluded that the conditions for non-linearity as established by Bowker and Lieberman <u>do not</u> exist at the chosen level of significance. Hence, this resulted in the acceptance of the null hypothesis for the F Test and the rejection of the alternate hypothesis that linearity <u>does not</u> exist.

TABLE 8

EVALUATION OF $k\sum_{i=1}^{n}(\overline{Y}_i - \tilde{Y}_i)^2/(n-2)$

$\overline{Y}_i$	$\tilde{Y}_i$	$\overline{Y}_i - \tilde{Y}_i$	$(\overline{Y}_i - \tilde{Y}_i)^2$
604.8	473.4	131.4	17265
714.2	823.4	-109.2	11924
1123.0	1173.4	- 50.4	2540
2033.0	1873.4	159.6	25472
2470.2	2573.4	-103.2	10650
3158.0	3273.4	-115.4	13317
3931.2	3973.4	- 42.2	1780
4765.4	4673.4	92.0	8464
5433.4	5373.4	60.0	3600
5846.4	6073.4	-227.0	51529
6974.8	6773.4	206.4	42436

$$\sum_{i=1}^{11}(\overline{Y}_i - \tilde{Y}_i)^2 = 188{,}977 \quad ;$$

with $k=5$ and $n=11$,

$$k\sum_{i=1}^{11}(\overline{Y}_i - \tilde{Y}_i)^2/(n-2) = 5\ (188{,}977)/9 = 104{,}887 \ .$$

TABLE 9

EVALUATION OF $\sum_{i=1}^{n} \sum_{\nu=1}^{k} (Y_{i\nu} - \bar{Y}_i)^2/n(k-1)$

X_i	$Y_{i\nu}$	$\bar{Y}_i$	$Y_{i\nu} - \bar{Y}_i$	$(Y_{i\nu} - \bar{Y}_i)^2$	$\sum_{i=1}^{n} (Y_{i\nu} - \bar{Y}_i)^2/44$
50K	788	604.8	183.2	33562	
	917	↓	312.2	97469	
	417	↓	187.8	35269	
	532	↓	72.8	5299	
	370	604.8	234.8	55131	5152.9
75K	725	714.2	10.8	116	
	680	↓	34.2	1170	
	845	↓	130.8	17109	
	749	↓	34.8	1211	
	572	714.2	142.2	20221	905.1
100K	1197	1123	74	5476	
	1356	↓	233	54289	
	986	↓	137	18769	
	1096	↓	27	729	
	977	1123	146	21316	2294.8
150K	2302	2033	269	72361	
	1709	↓	324	104976	
	1934	↓	99	9801	
	1992	↓	41	1681	
	2228	2033	195	38025	5164.5

TABLE 9--Continued

X_i	$Y_{i\nu}$	$\overline{Y}_i$	$Y_{i\nu} - \overline{Y}_i$	$(Y_{i\nu} - \overline{Y}_i)^2$	$\sum_{i=1}^{n} (Y_{i\nu} - \overline{Y}_i)^2/44$
200K	2567	2470.2	96.8	9370	
	2653		182.8	33146	
	2866		395.8	156658	
	2220		250.2	62600	
	2045	2470.2	425.2	180795	1006.4
250K	3271	3158	113	12769	
	2914		244	59536	
	3143		15	225	
	3355		197	38809	
	3107	3158	51	2601	2598.5
300K	4079	3931.2	147.8	21845	
	3941		9.8	96	
	4140		208.8	43597	
	3770		161.2	25985	
	3726	3931.2	205.2	42107	3037.0
350K	4749	4765.4	16.4	269	
	4942		176.6	31188	
	4660		105.4	11109	
	4627		138.4	19155	
	4849	4765.4	83.6	6989	1561.5

TABLE 9--Continued

X_i	$Y_{i\nu}$	$\bar{Y}_i$	$Y_{i\nu}-\bar{Y}_i$	$(Y_{i\nu}-\bar{Y}_i)^2$	$\sum_{i=1}^{n}(Y_{i\nu}-\bar{Y}_i)^2/44$
400K	5532	5433.4	98.6	9722	
	5349		84.4	7123	
	5826		392.6	154135	
	4988		445.4	198381	
	5472	5433.4	38.6	1489	8428.4
450K	5654	5846.4	192.4	37018	
	5976		129.6	16796	
	5793		53.4	2852	
	6109		262.6	68959	
	5700	5846.4	146.4	21433	3342.2
500K	7300	6974.8	325.2	105755	
	6661		313.8	98470	
	6542		432.8	187316	
	7129		154.2	23778	
	7242	6974.8	267.2	71396	11061.7

SELECTED BIBLIOGRAPHY

Books

Bakke, E. Wight. "Concept of the Social Organization." Modern Organization Theory. Edited by Mason Haire. New York: John Wiley and Sons, Inc., 1959.

Barnard, Chester J. The Functions of the Executive. Cambridge, Mass.: Harvard University Press, 1954.

Bollens, John C. The Metropolis. New York: Harper and Row, 1965.

Bowker, Albert H., and Gerald J. Lieberman. Engineering Statistics. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1959.

Bromage, Arthur W. Introduction to Municipal Government and Administration. New York: Appleton-Century-Crofts, Inc., 1950.

Chenery, Hollis B., and Paul G. Clark. Interindustry Economics. New York: John Wiley and Sons, Inc., 1959.

Churchman, C. West. Challenge to Reason. New York: McGraw-Hill Book Company, 1968.

Cleland, David I., and William R. King. Systems, Organizations, Analysis, Management: A Book of Readings. New York: McGraw-Hill Book Company, 1969.

Cleveland, Harlan. "A Philosophy for the Public Executive." Perspectives on Public Management: Cases and Learning Designs. Edited by Robert T. Golembiewski. Itasca, Illinois: F. E. Peacock Publishers, Inc., 1968.

Comprehensive Bibliography on Operations Research. Publications in Operations Research, Number 4. New York: John A. Wiley and Sons, Inc., 1958.

Devereux, Edward C., Jr. "Parsons' Sociological Theory." The Social Theories of Talcott Parsons: A Critical Examination. Edited by Max Black. Englewood Cliffs, New Jersey: Prentice-Hall, 1961.

Downs, Anthony. Inside Bureaucracy. Boston: Little, Brown, and Company, 1967.

Duncan, Acheson J. Quality Control and Industrial Statistics. Homewood, Illinois: Richard D. Irwin, Inc., 1965.

Elias, Claude E. Metropolis: Values in Conflict. Belmont, Calif.: Wadsworth Publishing Co., 1964.

Fisher, Robert Moore. The Metropolis in Modern Life. Garden City, New York: Doubleday and Sons, Inc., 1955.

Fisk, George, editor. The Analysis of Business Systems. Lund, Sweden: CWK Gleerup Publishers, 1967.

Gordon, David. The Ascertaining of Linearity. Doctoral Research Report Series of the School of Industrial Engineering of the University of Oklahoma, I-69. Norman, Oklahoma, April 15, 1969.

Gottmann, Jean. Megapolis. New York: Twentieth Century Fund, 1961.

Governmental Manpower for Tomorrow's Cities: A Report of the Municipal Manpower Commission. New York: McGraw-Hill Book Company, 1962.

Hatt, Paul K., and Albert J. Reiss, Jr., editors. Reader in Urban Sociology. Glencoe, Illinois: The Free Press, 1951.

Herrmann, Cyril. "The City As A System." Science, Engineering, and the City. Washington, D. C.: National Academy of Sciences, 1967.

Hicks, Herbert G. The Management of Organizations. New York: McGraw-Hill Book Company, 1967.

Kammerer, Gladys, and others. The Urban Political Community. Boston: Houghton Mifflin Company, 1963.

MacDonald, Austin F. American City Government and Administration. New York: Thomas Y. Crowell Company, 1951.

March, James G., and Herbert A. Simon. Organizations. New York: John Wiley and Sons, Inc., 1966.

Miernyk, William H. The Elements of Input-Output Analysis. New York: Random House, Inc., 1966.

Miller, David W., and Martin K. Starr. Executive Decisions and Operations Research. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1960.

Mosher, Frederick, and others. City Manager Government in Seven Cities. Chicago: Public Administration Service, 1940.

Municipal Year Book, The. Chicago: The International City Managers' Association, 1956, 1957, 1958, 1960, 1961, 1962, 1963, 1964, 1965, 1966.

Nigro, Felix A. Public Personnel Administration. New York: Henry Holt and Company, 1959.

Parsons, Talcott. "The Point of View of the Author." The Social Theories of Talcott Parsons: A Critical Examination. Edited by Max Black. Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1961.

________, and Edward A. Shils. Toward a General Theory of Action. Cambridge, Mass.: Harvard University Press, 1951.

Pfiffner, John M. Municipal Administration. New York: The Ronald Press Company, 1940.

________. Organization: A Study of Hierarchy. Los Angeles: University of Southern California, 1957.

Reed, Thomas Harrison. Municipal Management. New York: McGraw-Hill Book Company, Inc., 1941.

Ridley, Clarence E., and Orin F. Nolting. How Cities Can Cut Costs. Chicago: International City Managers' Association, 1945.

________, and Herbert A. Simon. Measuring Municipal Activities. Chicago: International City Managers' Association, 1943.

Simon, Herbert A. Administrative Behavior. Second Edition. New York: The Free Press, 1965.

________. "Organization and Management." Planning for Postwar Municipal Services. Chicago: International City Managers' Association, 1945.

Steel, Ernest W. Municipal Affairs. Second Edition. Scranton, Pennsylvania: International Textbook Company, 1950.

Stewart, Frank Mann. A Half Century of Municipal Reform. Los Angeles: University of California Press, 1950.

Technique of Municipal Administration, The. Third Edition, 1947. Chicago: International City Managers' Association.

Technique of Municipal Administration, The. Fourth Edition, 1958. Chicago: International City Managers' Association.

Thompson, James D. Organizations in Action. New York: McGraw-Hill Book Company, 1967.

Thorndike, E. L. Your City. New York: Harcourt, Brace and Company, 1939.

Trull, Edna. The Administration of Regulatory Inspectional Services in American Cities. New York: Municipal Administration Service, 1932.

Waldo, Dwight. The Administrative State: A Study of the Political Theory of American Public Administration. New York: Ronald Press Company, 1948.

________. The Study of Public Administration. New York: Random House, Inc., 1955.

Wildavsky, Aaron. The Politics of the Budgetary Process. Boston: Little, Brown, and Company, 1964.

Journals

Arbena, Joseph. "The 1962 Census of Governments." Public Management. Journal of the International City Managers' Association, XLIX (March, 1962), 57-59.

Argyris, Chris. "The Organization and the Individual." Administrative Science Quarterly (June, 1957), pp. 1-24.

Claire, William H. "The Future." Journal of the Urban Planning and Development Division, American Society of Civil Engineers, XCIII (September, 1967), 55-67.

Clark, Robert A. "New Techniques for City Planning." Public Management. Journal of the International City Managers' Association, XLIV (November, 1962), 249-253.

Feely, James K. "An Analysis of Administrative Purpose." American Political Science Review, XLV (December, 1951), 1069-1080.

Harding, Charles F. "The Social Anthropology of American Industry." American Anthropologist, LVII (December, 1955), 1218-1231.

Hardt, Erich. "Manpower Planning." Personnel Journal, XLVI (January, 1967), 157-161.

Hatcher, Harry. "Diversity of City Jobs Complicates Safety Program." Public Works, XCVIII (February, 1967), 86-88.

"Introduction to Handbook of Municipal Accounting." Journal of Accounting Research, V (Autumn, 1967), 180-185.

Irwin, Neal A., and Daniel Brand. "Planning and Forecasting Metropolitan Development." Traffic Quarterly, XIX (October, 1965), 520-540.

Isard, Walter, and Robert E. Kuenne. "The Impact of Steel Upon the Greater New York - Philadelphia Industrial Region." The Review of Economics and Statistics, XXXV (November, 1953), 289-301.

Joplin, Bruce. "Local Government Accounting: It's Your Responsibility, Too." Journal of Accountancy, CXXIV (August, 1967), 38-43.

Lorig, Arthur N. "Suggested Improvements in Governmental Accounting." Accounting Review, XXXVIII (October, 1963), 759-763.

Martin, Roscoe C. "Manpower for Cities." Public Management. Journal of the International City Managers' Association, XLVI (February, 1963), 26-30.

McHale, J. "Science, Technology, and Change." Annals of the American Academy of Political and Social Science, 373 (1967), pp. 120-140.

Moore, Frederick T., and James W. Petersen. "Regional Analysis: An Interindustry Model of Utah." The Review of Economics and Statistics, XXXVII (November, 1955), 376-377.

Morey, Lloyd. "Greater Recognition Is Needed of Applicable Principles in Governmental and Institutional Accounting." Accounting Review, XXXIII, 469-471.

Parsons, Talcott. "Suggestions for a Sociological Approach to the Theory of Organization - I." Administrative Science Quarterly, I (June, 1956), 63.

"Plotting Future Manpower Requirements." Management Review, L (December, 1961), 40-43.

Rapoport, Leo A., and William P. Drews. "Mathematical Approach to Long-Range Planning." Harvard Business Review, XL (May - June, 1962), 75-87.

Simon, Herbert A. "Comments on the Theory of Organization." American Political Science Review, XLVI (December, 1952), 1130.

Thompson, James D. "Common and Uncommon Elements in Administration." Reprinted from The Social Welfare Forum, 1962. New York: Columbia University Press, 1962.

Thorndike, Robert L. "The Problem of Classification of Personnel." Psychometrika, XV (September, 1950), 215-235.

Bulletins and Pamphlets

Council of State Governments, The, and Others. Planning, Programming, Budgeting for City, State, County Objectives. State-Local Finances Project of the George Washington University. Washington, D. C., January, 1967.

________. Planning, Programming, Budgeting for City, State, County Objectives. State-Local Finances Project of the George Washington University. PPB Notes 1, 2, 3. Washington, D. C., January, 1967.

Hatry, Harry P., and John F. Cotton. Program Planning for State, County, City. State-Local Finances Project of the George Washington University. Washington, D. C., January, 1967.

Technique for Area Planning. Regional Economic Development Institute. Springfield, Virginia: Clearinghouse, 1968.