# A MANAGEMENT GAME FOR CITY MANAGERS AND ADMINISTRATORS

By

CHARLES MOODY PARKS

Bachelor of Science
Oklahoma State University
Stillwater, Oklahoma
1972

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1973

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF PHILOSOPHY
December, 1975

A MANAGEMENT GAME FOR CITY MANAGERS AND
ADMINISTRATORS

Thesis Approved:

Thesis Adviser

M. P. Terrell

Earl J. Ferguson

Donald W. Grace

N. N. Durham
Dean of the Graduate College

ACKNOWLEDGEMENTS

The opportunity to study Industrial Engineering and Management here at Oklahoma State University has been one of pleasant association with both classmates and professors.

The writing of a dissertation and the conferral of the Ph.D. is the joint effort of the candidate and his committee. I was extremely fortunate to have a committee made up of men who were all inspirational to me both in and out of the classroom. Dr. J. E. Shamblin always seemed to be doing enough work for two men, yet he patiently found the time to guide me through my research and the writing. (I also benefitted from his profound discourses on sports cars, motorcycles and fishing.) Dr. E. J. Ferguson's wisdom and salient remarks helped me to understand more about myself and my role as an industrial engineer. Dr. M. P. Terrell's demands upon me as a graduate student helped me to mature and become more self-reliant in my thinking. Dr. D. W. Grace's example of academic excellence coupled with warm human kindness further increased my understanding of the lesson of humility. I shall carry these men's direct and indirect contributions to my education with me the rest of my life.

My thanks go to the Graduate College and the School of Industrial Engineering and Management for funding the early stages of this research. The diligence and zeal of my typist, Grayce Wynd, kept me moving in the latter stages when I was really getting "tired of the whole thing."

I deeply appreciate my wife, Gayla, who continually sacrificed her time and who understood (most of the time) why I seemed to be spending my whole life as a student. I thank my parents, Mr. and Mrs. Moody R. Parks, who understand the importance of an education and who stood by me in both good times and bad.

TABLE OF CONTENTS


Chapter | Page

I. INTRODUCTION TO GAMES . . . . . . . . . . . . . . . . . . . 1

Simulation and Gaming . . . . . . . . . . . . . . . . 1
A Brief History of Operational Gaming . . . . . . . 3
Military Gaming . . . . . . . . . . . . . . . . 3
Management Gaming . . . . . . . . . . . . . . . 4
Research Objectives . . . . . . . . . . . . . . 5

II. LITERATURE REVIEW . . . . . . . . . . . . . . . . . . . . 7

Educational Simulation Techniques . . . . . . . . . 7
On-the-job Training . . . . . . . . . . . . . . 7
Case Studies . . . . . . . . . . . . . . . . . 8
"In-basket" Methods . . . . . . . . . . . . . . 8
Role Playing . . . . . . . . . . . . . . . . . 8
Operational Gaming . . . . . . . . . . . . . . 9
Computer Simulation . . . . . . . . . . . . . . 9
Game Classification . . . . . . . . . . . . . . . . 10
General or Local Environment . . . . . . . . . 10
Total Enterprise or Functional . . . . . . . . 10
Deterministic or Stochastic . . . . . . . . . . 10
Interactive or Non-interactive . . . . . . . . 11
Individual or Multi-participants . . . . . . . 11
Horizontal or Vertical Organization Structure 11
Single or Multi-educational Goals . . . . . . . 11
Game City, Marilyn Clayton, WGRH Educational Foundation, 1969 . . . . . . . . . . . . . 12
Community Level Use Game, Alan G. Feldt, Cornell University, 1966 . . . . . . . . . 12
A Model of Metropolis, I. S. Lowry, RAND Corporation, 1964 . . . . . . . . . . . . . 13
City Model, P. House, P. Patterson, Environmental Studies Division, EPA, Washington, D. C. . . . . . . . . . . . . . 13
Metropolis, Richard D. Duke, University of Michigan, 1969 . . . . . . . . . . . . . . 13

III. GAME DEVELOPMENT . . . . . . . . . . . . . . . . . . . 15

Preliminary Considerations . . . . . . . . . . . . 15
Functional Relationships . . . . . . . . . . . . . 16
Defining Parameters . . . . . . . . . . . . . . 16

Chapter | Page


Determining Functions . . . . . . . . . . . 16
Game Design . . . . . . . . . . . . . . . . . . . . . 22
Verisimilitude . . . . . . . . . . . . . . . 23
Game Structure . . . . . . . . . . . . . . . 23

IV. GAME DESCRIPTION . . . . . . . . . . . . . . . . . . .

The City System . . . . . . . . . . . . . . . . 25
System Rationale . . . . . . . . . . . . . . 25
Departmental Parameters . . . . . . . . . . 27
Game Components . . . . . . . . . . . . . . . . 28
Input Decisions . . . . . . . . . . . . . 28
Output Reports . . . . . . . . . . . . . . 28
Decision Returns . . . . . . . . . . . . . . . 29
Return Curves . . . . . . . . . . . . . . 29
Functional Relationships . . . . . . . . . . 32
Sensitivity Analysis . . . . . . . . . . . 37

V. CONCLUSIONS AND RECOMMENDATIONS . . . . . . . . . . . 42

Conclusions . . . . . . . . . . . . . . . . . . 42
Recommendations . . . . . . . . . . . . . . . . 43

A SELECTED BIBLIOGRAPHY . . . . . . . . . . . . . . . . . . 44

APPENDIX A . . . . . . . . . . . . . . . . . . . . . . . 47

APPENDIX B . . . . . . . . . . . . . . . . . . . . . . . 69

APPENDIX C . . . . . . . . . . . . . . . . . . . . . . . 75

## LIST OF TABLES


| Table | | Page |
|---|---|---|
| I. | Input Parameters . . . . . . . . . . . . . . . . . . | 17 |
| II. | Constants Obtained by Regression Analysis . . . . . | 22 |
| III. | Employee Satisfaction versus Pay and Manpower for a City of 50,000 . . . . . . . . . . . . . . . . | 35 |
| IV. | Sensitivity of the Decreasing Returns Curve to the Constant $C_1$ . . . . . . . . . . . . . . . . . . . | 40 |
| V. | Sensitivity of the Increasing Returns Curve to the Constant $C_3$ . . . . . . . . . . . . . . . . . . . | 40 |
| VI. | Relation of Model City Departments and OML Job Classifications . . . . . . . . . . . . . . . . . . | 49 |
| VII. | Number of Police Department Employees for Selected Cities with Populations from 5,000 to 74,000 . . | 51 |
| VIII. | Number of Fire Department Employees for Selected Cities with Populations from 5,000 to 74,000 . . | 52 |
| IX. | Number of Parks and Streets Department Employees for Cities with Populations from 5,000 to 74,000 | 53 |
| X. | Number of Garbage Department Employees for Selected Cities with Populations from 5,000 to 74,000 . . | 54 |
| XI. | Number of Utilities Department Employees for Selected Cities with Populations from 5,000 to 74,000 . . . . . . . . . . . . . . . . . . . . | 55 |
| XII. | Number of Employees in Salary Range by Department for Cities Grouped in Populations of 3,500 to 6,499 . . . . . . . . . . . . . . . . . . . . . | 56 |
| XIII. | Number of Employees in Salary Range by Department for Cities Grouped in Populations of 16,500 to 23,499 . . . . . . . . . . . . . . . . . . . . | 57 |
| XIV. | Number of Employees in Salary Range by Department for Cities Grouped in Populations of 26,500 to 33,499 . . . . . . . . . . . . . . . . . . . . | 58 |

LIST OF FIGURES

Figure Page

1. Number of Police Department Employees versus Population X $10^{-3}$ . . . . . . . . . . . . . . . . . . . . 19

2. Average Monthly Salary for Police Department Employees versus Population X $10^{-3}$ . . . . . . . . . . . 21

3. A Hypothetical City System . . . . . . . . . . . . . 26

4. A Typical Increasing Return Curve . . . . . . . . . . 31

5. A Typical Decreasing Return Curve . . . . . . . . . . 33

6. The Relationship of the Curve Shaping Constants ($C_1$, $C_2$, $C_3$, $C_4$) to the Decreasing Returns Curve . . . . 38

7. The Relationship of the Curve Shaping Constants ($C_1$, $C_2$, $C_3$, $C_4$) to the Increasing Returns Curve . . . . 41

8. Number of Police Department Employees versus Population X $10^{-3}$ . . . . . . . . . . . . . . . . . . . . 59

9. Number of Fire Department Employees versus Population X $10^{-3}$ . . . . . . . . . . . . . . . . . . . . 60

10. Number of Parks and Streets Department Employees versus Population X $10^{-3}$ . . . . . . . . . . . . . . 61

11. Number of Garbage Department Employees versus Population X $10^{-3}$ . . . . . . . . . . . . . . . . . . 62

12. Number of Utilities Department Employees versus Population X $10^{-3}$ . . . . . . . . . . . . . . . . . . 63

13. Average Monthly Salary for Police Department Employees in Selected Cities . . . . . . . . . . . . . . 64

14. Average Monthly Salary for Fire Department Employees versus Population X $10^{-3}$ . . . . . . . . . . . . . . 65

15. Average Monthly Salary for Parks and Streets Department Employees versus Population X $10^{-3}$ . . . . . . 66

Figure | Page

16. Average Monthly Salary for Garbage Department Employees versus Population X $10^{-3}$ . . . . . . . . . . . . 67

17. Average Monthly Salary for Utilities Department Employees versus Population X $10^{-3}$ . . . . . . . . . . 68

# CHAPTER I

# INTRODUCTION TO GAMES

The word "game" carries a special connotation for most people. Generally, the uninitiated associate games with play and recreation. However, practically all games that people have participated and currently participate in have a certain amount of educational value. Boocock (6) conjectures that children's games serve as an introduction to life's rules of social interaction and appear to provide an important means of learning about and experimenting with life. Educational game designers usually develop an educational game from their desire to illustrate certain principles from a body of knowledge about a subject. Thus, the game serves to isolate and emphasize a certain amount of knowledge about a subject. Games with a simulated environment or simulation games are the class of games which are of primary interest in learning environments. Hereafter, the words "game" and "operational gaming" will be used interchangeably. The following presents an introduction to gaming.

## Simulation and Gaming

Simulation and gaming are very similar, but a distinction between the two should be made so that the tastes of those people interested in the two fields can be satisfied.

The new field known as operations research has grown from the desire to quantify the operational activities of organizations. Early operations researchers attempted to build mathematical models to represent various operations of large organizations. These early efforts met with as much failure as they did with success. The complexities of even the simplest operational activity with all of the nuances associated with any human organization were astounding. The simplifying assumptions that the engineers had to make often moved the model too far from reality to provide any useful results. As the field of operations research grew, however, the analytical tools for the researchers improved and so did their mathematical models. During this same period of technological innovation, the powers of the digital computer expanded as well as did the ambitions of the operations researchers.

Eventually, some of the researchers realized that many of the systems which they were trying to model analytically were simply too complex to be mathematically tractable. The scientists needed an experimental laboratory which they could use to somehow replicate the large scale systems that they were attempting to study. From this need, the field of computer simulation was developed. Thus, simulation, and particularly Monte Carlo simulation, has grown to be the experimental arm of the field of operations research. Properly used, simulation can provide valuable insight into the analysis of complex systems and can provide a sound basis for quantitative decision making. If the model is well designed, system decisions can be tested on the model so that their effects on the real system can be economically predicted.

Therefore, a good simulation model, by definition, must have the capability of predicting the effects of parameter changes on the real system. Although operational games can be thought of as a form of simulation, they do not necessarily have predictive capabilities because their objectives are different.

Operational gaming can be considered to be a subset of simulation. However, the objectives of a game are distinctly different from those of a simulation. While simulation models are used to develop decision rules, operational games are used primarily in training human decision-makers. Thus, the analytical "purist" may be somewhat disappointed with the lack of sophistication of most game models. However, the history of operational games seems to indicate that a complex simulation model often makes a poor game.

## A Brief History of Operational Gaming

Operational gaming has enjoyed a rather long history. The earliest beginnings are found with the military war games which have been developed over the past two hundred years. War gaming has been a very successful training device for the military. This success led industrial leaders to believe that gaming could have application in training business decision-makers. Many management games have been developed since the middle 1950s, and educators have also developed gaming concepts as a tool for the public classroom.

### Military Gaming

The science of war gaming has a rather cloudy origin. One early military game developer states that war games had their origins in the ancient game of chess in which the "relative values and powers of the various arms formed the important study." He further asserts that checkers is governed by "the great underlying military principle of decisive concentration at an opportune moment" (Totten, 37). Probably the first modern war game was the German game of Kriegsspiel, which originated in Prussia in the early 19th century. Kriegsspiel transferred the military rules from the checkerboard onto a map. Kriegsspiel spawned a number of variations which made their way to the United States in the early 1870s. Since the late 1800s, the concept and practice of war gaming have gained wide acceptance. Military games now range from full scale exercises involving actual equipment and men in joint Army, Air Force, and Navy operations, costing millions of dollars to the simpler map exercises used to train junior officers in tactical decision-making. These costly exercises are justifiable because of the high stakes in human life and national security that are involved. The refereed military game allows military decision-makers to be trained in an environment where a mistake can be made without the obvious potential disasters occurring if the same "on-the-job-training" were in a real battlefield situation. In a game, creative and daring decisions can be made with the worst consequence being a bruised professional ego. These game benefits and the advent of the modern high speed computer brought industrial decision-makers into the field of gaming, and the first management games grew from the earlier military experiences.

## Management Gaming

Historically, management training has virtually been one of actual work experience. The romantic story of the janitor who rose to top management was often very true. Since World War II, however, the explosion of technology and higher education have seen the advent of a new professional manager. Characterized by college degrees, often at the graduate level, this new professional usually begins at lower management assignments and proceeds from there. In effect, these jobs are training programs with some participants being formally called management trainees. Many of the new trainees are rotated from assignment to assignment at various company functions in the attempt to give the new executive a broadening experience in the hope that he will begin to view the company as a total system. Most of these training programs rely heavily on on-the-job learning and coaching from senior executives. On-the-job coaching is rather slow and inefficient, but was virtually the only method which could give the needed managerial experience. The need for a management "laboratory" persisted, and war gaming philosophies were seen as adaptable to the business environment.

Greenlaw (17) attributes the American Management Association with developing the first management game in 1957. "Top Management Decision Simulation" was the title of the game, and it was used in the Academy of Advanced Management at Saranac Lake, New York. Since then, educational gaming has been applied to many fields, and the literature abounds with games for many age groups and various learning objectives.

## Research Objectives

The objective of this research is to develop a managment game for city administrators. Developing the required model will include the establishment of functional relationships between the input decisions and the output results. The game will be based on the hypothesis that decision variables such as the number of men, salaries, and the budget can be related to the level of service that can be attained by a city department. Further, it is hypothesized that these functional relationships can be established between the decision variables and the size of the population being served.

# CHAPTER II

# LITERATURE REVIEW

Operational games are primarily simulation methods applied to educational situations. They can be put on a continuum of simulation technique ranging from reality (actual on-the-job training) to full scale predictive simulation. Further insight into the role of games can be rendered by classifying games according to function or purpose. A game's objectives direct the research and development needed to meet the given criteria.

## Educational Simulation Techniques

Several methods of training can be related to simulation gaming techniques in that they attempt to train by experimental methods. These are listed in order of increasing abstraction after Taylor (36).

### On-the-job Training

OJT is, of course, not an abstraction of reality. It is included here as the lowest level of abstraction possible. Usually, the decision-maker is given limited amounts of freedom in applying his skills to the work experience. At first, much coaching is necessary, but as the training progresses, the trainee assumes more responsibility. On-the-job training is the ultimate in experiential learning, but it is rather inefficient and time-consuming.

## Case Studies

Case studies involve detailed descriptions of problem situations which the student is required to analyze and discuss. These exercises were pioneered at Harvard, and are used extensively in many educational programs. As Taylor (36) points out, no matter how realistic the study may be, it is basically a static tool, for as soon as the case has been studied and discussed, it is no longer useful.

## "In-basket" Methods

"In-basket" methods are designed to produce specific situations. An individual is given a tray of the morning's mail and memoranda for a specified job. He assumes the managerial role and acts upon the correspondence within a set time frame. The performance is measured, not only upon his reactions to the correspondence, but also upon his manner of prioritizing the execution. "In-basket" training is an important step toward involving the participant in an actual decision-making process.

## Role Playing

Role playing is a training technique which utilizes dramatic methods to illustrate management problems. A scenario with roles for the participants is developed and the drama is acted out. The spontaneous enactment of the roles illustrates and dramatizes human problems and actions. Role playing is quite effective in creating realistic and life-like situations. Role playing is used primarily for human relations training.

## Operational Gaming

Operational gaming attempts to combine quantifiable decision-making with qualitative situations. Participants are assigned the decision-making role and are given the situational background or scenario. The rules and constraints of the game are explained, and play begins. Games can be one-person or multi-person exercises and can be used to develop very explicit skills (such as resource allocation) or more general managerial skills. Good feedback and scoring provide a dynamic realism which promotes participant enthusiasm.

## Computer Simulation

A computer simulation usually uses Monte Carlo methods to develop a predictive model of the system which is being simulated. The decision-maker is not usually considered to be in a training situation as the other five techniques described above assumed. Rather, the simulation is another decision-making tool which the manager uses to test rules and philosophies of decision. Decisions are made and the simulator predicts the outcome of these decisions. Computer simulations can be very precise in the handling of quantifiable factors.

The above description of simulation techniques is an effort to place them on a continuum ranging from low abstraction to high abstraction. The implied boundaries between the six listed techniques are artificial and actually much overlap exists. The definitions merely serve as a guideline for the reader to help him put operational gaming in a proper perspective. Games themselves can be loosely classified according to their functions or objectives.

## Game Classification

As noted previously, the field of operational gaming and operations simulation are very closely related. There is much confusion among neophytes as well as seasoned practitioners relating to the differences between the two fields. To make matters worse, some gaming enthusiasts avoid the word "game" and use "simulation" instead. They do this primarily because of the connotations of frivolity attached to the word "game."

The following general characteristics (adapted from Greenlaw, 17) of games can aid in the classification of game types:

### General or Local Environment

A game can be designed to develop skills that might be applicable to any public administration post or it might be aimed particularly at local city officials. In a business context, games are designed to develop general business skills and/or they are tailored to a specific industry like the petroleum or steel industries.

### Total Enterprise or Functional

A game may involve nearly all of the aspects of a managerial operation, the "total enterprise," or it may stress a functional area such as production or marketing.

### Deterministic or Stochastic

A game's functional relationships may not involve any randomness and thus be strictly deterministic, or the element of chance can be introduced to form stochastic functions.

Interactive or Non-interactive

If a game is developed for team play, competitive decisions among the teams which affect each other mean that the game is interactive. For example, a marketing game may have competition for the teams' shares of the market. If the teams' decisions don't affect each other, then the game is said to be non-interactive. Such a non-interactive game might be a project management game where teams are judged on costs or completion time, etc.

Individual or Multi-participants

The characteristic interactive or non-interactive implies that more than one person can be included in a game. Games can be designed either for individual play or for several players.

Horizontal or Vertical Organization Structure

If all participants are equal in hierarchial status, then the game is on a horizontal level. However, if the participants occupy roles which represent different organization levels, then the game is one which has vertical levels.

Single or Multi-educational Goals

If one specific managerial skill or technique is to be employed, then the game is said to have a single educational goal. If more than one skill is involved, then the game has multi-educational goals.

The above characteristics were useful in surveying the literature on simulation and gaming. A vast amount of literature on the topic of operational gaming exists, as well as a myriad of various games. Because of this mass of literature, the survey was limited to research on games that were particularly aimed at urban problems.

Several games exist which deal with urban affairs.

Game City, Marilyn Clayton, WGRH Educational Foundation, 1969

"Game City" is a manual game which is aimed primarily at high school students. The game has three broad roles which are played by teams. The roles are City Administration, Urban Council, and Suburban League. The game's objectives are to demonstrate how a government attempts to solve problems by identifying consensus among many divergent points of view.

Community Level Use Game, Alan G. Feldt, Cornell University, 1966

CLUG is a game in urban economics which was developed for high school to adult groups. The players are divided into three to five teams of private entrepreneurs. The primary objectives are to teach the classical principles of urban and regional economics.

Numerous other specialized city games have been developed which deal primarily with social and political problems.

Three large-scale operational models have been developed for urban reseach.

A Model of Metropolis, I. S. Lowry,
RAND Corporation, 1964

"Metropolis" is a computer model of the spatial organization of human activities within a metropolitan area. The model is intended for eventual use as a device for evaluating the impact of public decisions. The model is used to give some tentative predictions of the emerging spatial structure of Pittsburgh.

City Model, P. House, P. Patterson, Environmental Studies Division, EPA, Washington, D. C.

"City" is a large scale sophisticated game used for training people in the concepts of dynamic urban decision-making. From 20 to 120 players in their roles as economic, social, and/or governmental decision-makers, interact and make decisions. "City" was developed for the EPA and took five years and eighty million dollars to complete. The game has data files which can simulate cities ranging from 10,000 to 1.6 million population.

Metropolis, Richard D. Duke, University of Michigan, 1969

"Metropolis" is another computerized game which can be played in teams. The city politician, city planner, city administrator, and real estate speculator make decisions regarding land investments and capital budgeting. The objectives are to promote the understanding of some of the processes which influence the growth and development patterns of a moderate-size city.

Zuckerman (40) and Belch (3) list several other city games that are currently available. Each game is designed for a particular audience and an assigned age group. These games are designed to train adults in land development, teach children socio-economics of cities, emphasize transportation problems, etc. Many games exist which are aimed at urban problem areas, but apparently none exists which can be called a management game for city managers.

## CHAPTER III

## GAME DEVELOPMENT

Early research into the development of the game showed much doubt about the feasibility of a management game for city managers. The corporate management game's profit and loss statement was not available as a measure of successful play. After preliminary considerations, functional relationships were established which paved the way for model studies and eventually the final game design.

### Preliminary Considerations

A management game was desired which could be used as an aid in training potential managers and department heads for cities with a population of less than one hundred thousand. The selection of this population range was predicated on the assumption that people who are being groomed as city managers for the large urban areas usually have prior training and experience in the smaller cities. Also, according to the 1974 Municipal Yearbook (42), this population range represents roughly half the urban population. The primary purpose of the game was to dynamically expose the player to the problem of allocation of limited resources, namely men and money, to the entire city. The game was to be principally for city manager trainees and department heads who would profit from a systems approach in their training. Another consideration for the development of the game was simplicity of play. McKenney (26) claims that a game should be simple enough to be understood at the start. With these initial considerations, the game's parameters and functional relationships can be developed.

## Functional Relationships

As stated previously, the basic hypothesis of this research is that a functional relationship exists between the input decision variables and the level of service that can be attained by a city department. Further, it is hypothesized that a functional relationship exists between these inputs and the city's population. First, the basic game parameters were defined, and then the functional relationships were determined.

### Defining Parameters

In any city's work system, there are a myriad of parameters that describe the system which are complexly related to one another. Political considerations and other related complexities are beyond the scope of this study.

Table I shows the city parameters which are decision variables that are input by the player. The table shows the parameters in order of their appearance in the game. These parameters completely describe the city of Pleasantview as seen by the player. Their complex functional interrelationships are internal to the game's model.

### Determining Functions

Determining a functional relationship between the input departmental decision variables and the city's population was desired. In conjunction with this relationship, functional relationships were needed to determine the return or score that a player would receive for a given set of input decisions. On a practical level, the problem translates to: Given a city's population--what is the correct number of firemen, policemen, etc., and what should be their level of pay for satisfactory service?

TABLE I

INPUT PARAMETERS

| Parameter | Description |
|---|---|
| Population | Determines city size |
| Revenue | Sets the quarterly budget |
| Revenue Sources | Determine the sources of the revenue |
| 1) Sales tax | |
| 2) Garbage fees | |
| 3) Utility fees | |
| 4) Property tax | |
| Departments | Each department has three input parameters |
| 1) Budget | Fixes the departmental quarterly budget |
| 2) Manpower | The number of men in the department |
| 3) Salary | The amount of the budget allowed to salaries |

Data which could possibly be used to relate city size with departmental manpower and salaries are not readily available. Searching statistical abstracts was virtually no help. Most data were on such macroscopic levels that they were not useful. One notable exception was the FBI's Annual Report (41) which yielded the police department data for all cities in the United States. However, the hypothetical city was to have five other departments.

In an effort to determine the correct relationships, a first thought was that an interview method, such as the Delphi technique, could be used. Experienced city managers were to be asked questions such as:

1) For a city of ______ population, how many men should the garbage department have to give satisfactory service?

2) What should their average monthly pay be?

Techniques such as this can be successful, however they can be time-consuming and often their results are questionable. Before this method of data collection was begun, another source of information was discovered. The Oklahoma Municipal League (43) conducts a confidential annual wage and salary survey which also contains departmental sizes for all of the participating cities in Oklahoma. The OML allowed this data base to be used and it was loaded onto an IBM System 360 and extracted in a form which was useable. The cities were put into population brackets and the population was rounded to the nearest one thousand (see Appendix A), and the analysis was begun. Scatter diagrams were drawn for each department (see Appendix A) in an effort to determine the functional relationships between population, department size, and average pay. Population was used as the independent variable and the number of employers and their average pay were the dependent variables. Figure 1 shows the scatter diagram shown for the police department which shows number of employees versus population. The

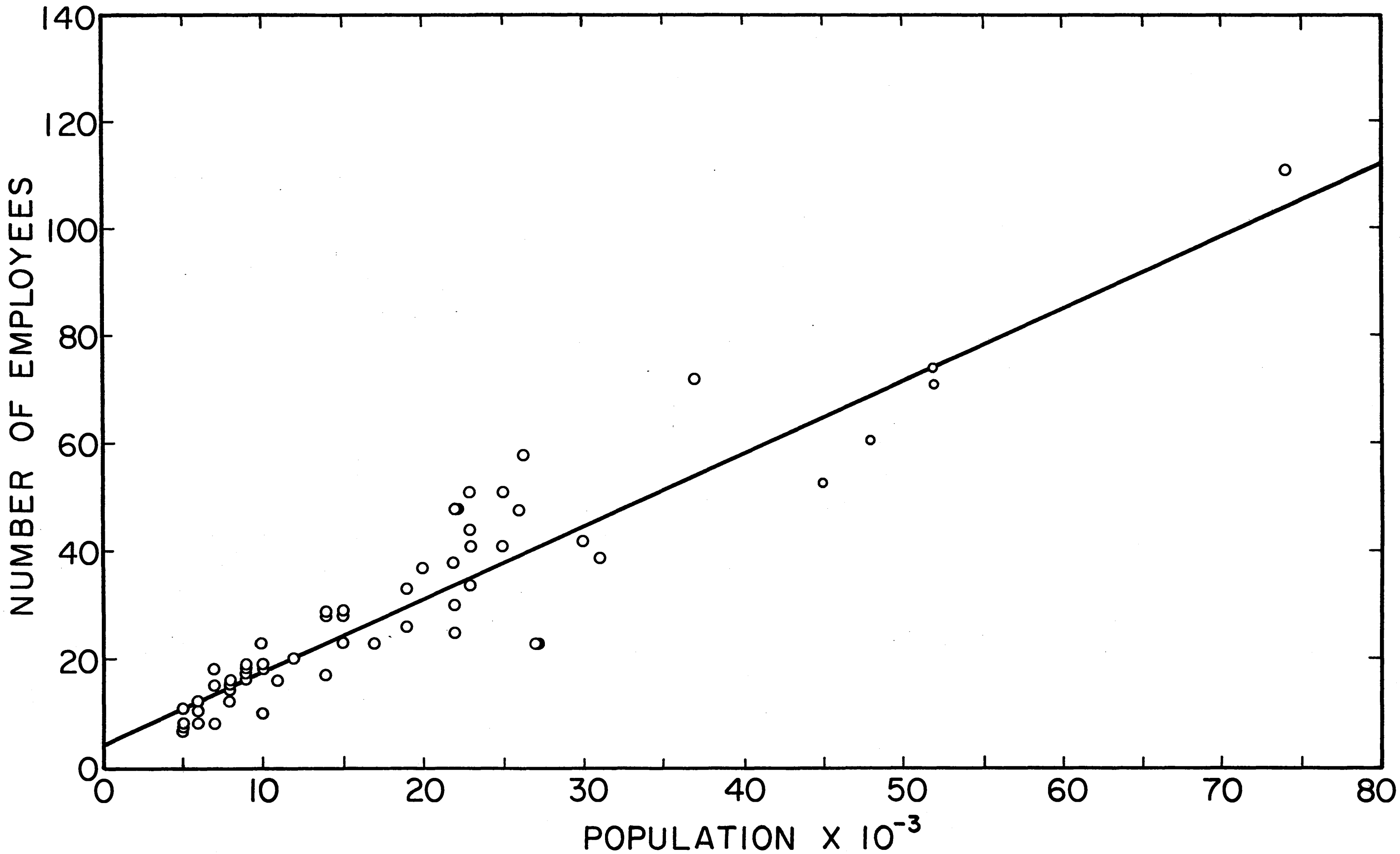


Figure 1. Number of Police Department Employees versus Population X $10^{-3}$

diagram shows a definite increase in department size as population increases.

Figure 2 shows the scatter diagram relating average pay with population. A regression analysis gave the following relationships:

$$M = C_1 \cdot \text{population}/1000 + C_2$$

$$P = C_1 \cdot \text{population}/1000 + C_2$$

where

$M$ = number of men

$P$ = monthly pay

$C_1$, $C_2$ = curve fitting constants

These constants are summarized in Table II. The theoretical relationships above are used to compute a theoretically correct quarterly budget for the hypothetical city in the following manner. For each department, the computed number of employees is multiplied by the computed average monthly pay. The five departments are summed and a one hundred percent overhead charge is added. This theoretical budget is compared to the player's budget decision when computing the player's decision return for the total city satisfaction. Here, the assumption is that an inverse relationship exists between excessive revenue and total city satisfaction (see Chapter IV, Game Description, for a more complete discussion of the decision return calculations). (The analysis did point out that a basic assumption needed to be changed. There seemed to be virtually no correlation between city size and the employee data for the streets department. In other words, as the population increased, the streets department size remained constant. A possible

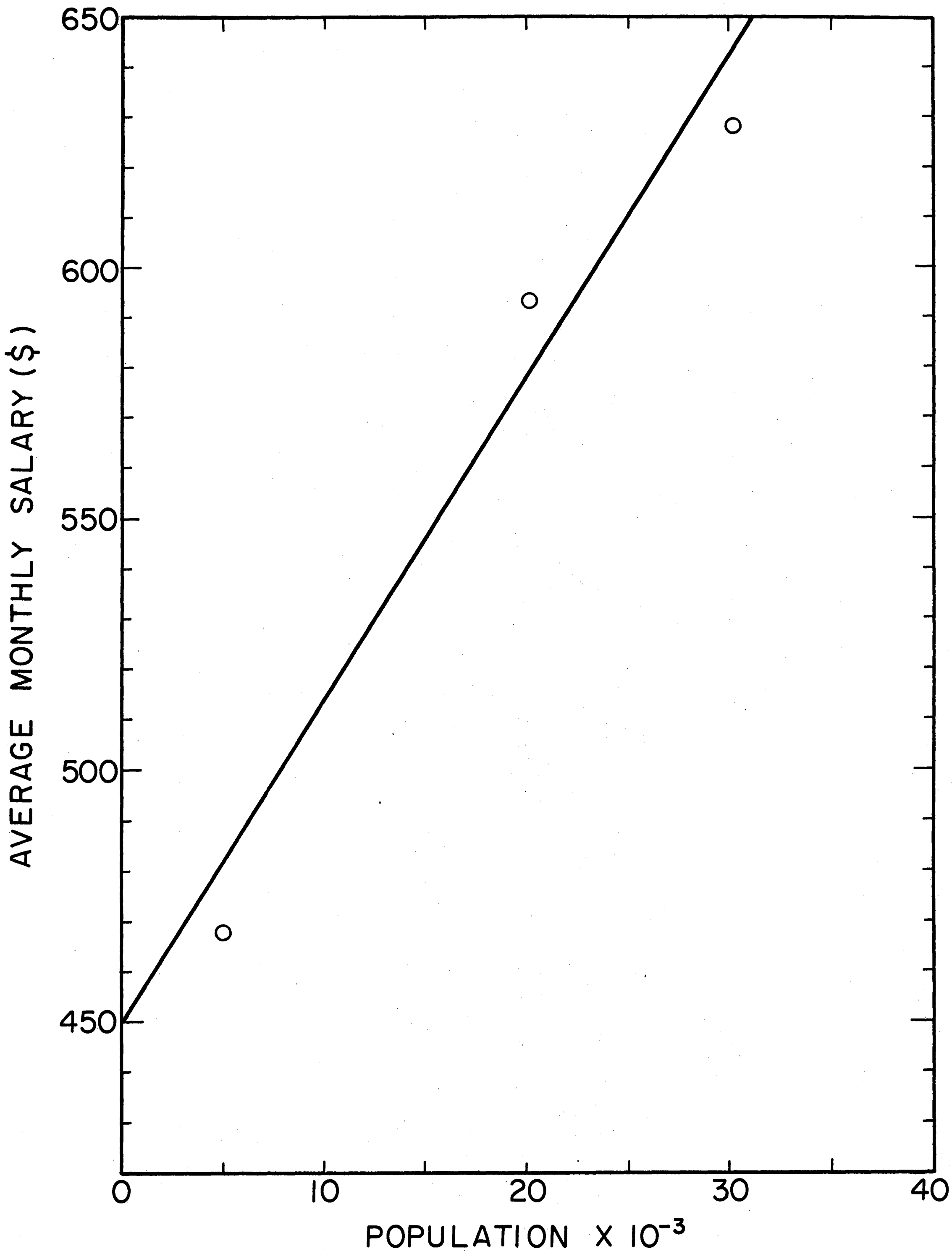


Figure 2. Average Monthly Salary for Police Department Employees versus Population X $10^{-3}$

explanation is one of definition. Thus, many city employees who work in the streets department are classified as laborers and actually work for more than one department. To circumvent this problem, the streets department was combined with parks, and thus the city was reduced to five departments.) The results of the data analysis seems to confirm the hypothesis that a relationship exists between population and department size and pay for the five departments in Pleasantview. These relationships were next incorporated into the design of the game.

TABLE II

CONSTANTS OBTAINED BY REGRESSION ANALYSIS

| Department | Manpower | | Pay | |
|---|---|---|---|---|
| | $C_1$ | $C_2$ | $C_1$ | $C_2$ |
| Police Services | 1.35 | 3.51 | 10.89 | 450 |
| Fire Protection | 1.40 | .23 | 7.24 | 467 |
| Parks and Streets | .35 | 1.75 | 7.14 | 407 |
| Sanitation | 1.00 | 2.67 | 2.84 | 420 |
| Utilities | 2.06 | 1.98 | 4.32 | 433 |

## Game Design

The game designer attempts to develop a management laboratory where the player can experiment with decisions and come to terms with the game. Hopefully, successful play will enhance the learning of the desired material. The important gaming concept of verisimilitude should be understood by the designer as well as the basic elements which are found in any management game.

## Verisimilitude

Greenlaw (17) and Kibbee (20) maintain that games do not need to be predictive, quantitative simulations. However, a game's value can be enhanced if the illusion of reality is supported by realistic assumptions. The analysis of the previous section provided the game with some reasonable functional relationships among the decision variables. The concept of an illusion of reality is called "verisimilitude" and is widely used in gaming and training simulators used in training fighter pilots. Verisimilitude means that a game model does not need to duplicate reality, but that the player or trainee needs to sense or feel that the model represents reality. In quantitative terms, verisimilitude means that if a dependent variable varies directly with the magnitude of an independent decision variable, then the actual shape of the curve which represents this functional relationship is not too important. What is important is that when a player increases the magnitude of his decision, he gets a larger return. Verisimilitude is basic to game design, but there are certain structural elements that are necessary for any management game.

## Game Structure

Game structure has been well defined by Zoll (39), who gives the following elements which are basic to any management game:

1. The application of limited resources among alternative uses.

2. A simulated environment.

3. Striving for the best possible results, but with the possibility of success or failure.

4. The feedback of consequences.

5. The basing of new decisions on these consequences.

6. Repeating steps one through five for as many cycles as desired.

With the above elements and the concept of verisimilitude, a game can be designed to represent almost any management area. A description of "Pleasantview" will show how the functional relationships were integrated into the final game design.

# CHAPTER IV

# GAME DESCRIPTION

The game was developed principally to illustrate the problems of allocating scarce resources among alternative uses. The city system was organized into five departments with decisions and output reports for each department and also the city as a whole. Return curves were created which enable the player to receive feedback on his decisions.

## The City System

The city system provides the basic services found in most of the cities in the intended population range (ten to one hundred thousand). The rationale for this system is based partly upon the departmental parameters.

### System Rationale

A hypothetical city system is shown in Figure 3. The two basic system inputs are revenue and manpower. The basic system outputs are police services, fire protection, parks and streets service, garbage services, and utilities. Each of these system outputs is also assumed to provide an input in the form of employee satisfaction. The model postulates that all cities in the population range of ten to one hundred thousand provide at least these five basic services. The OML data (43) corroborated these assumptions for most cities above ten

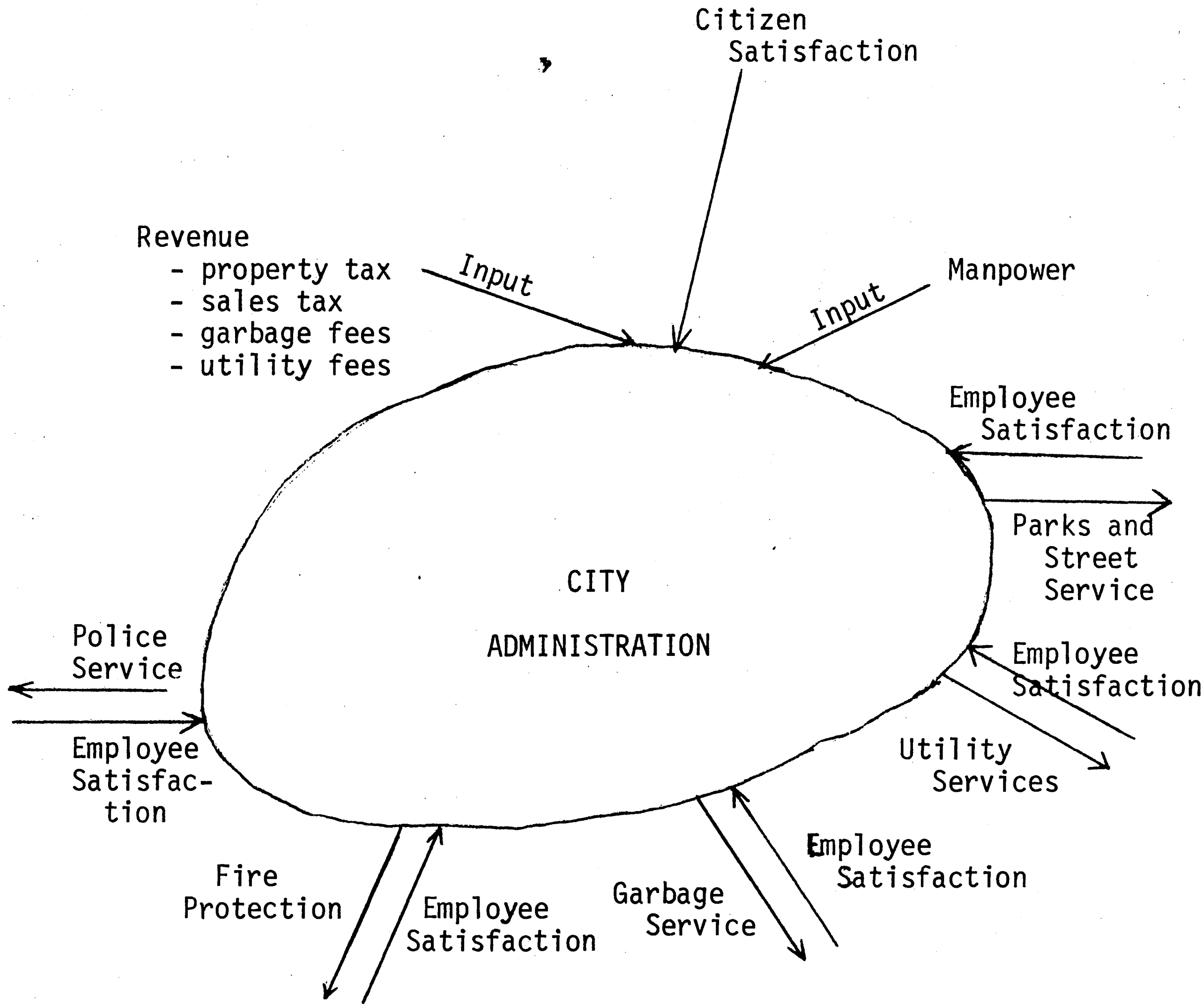


Figure 3. A Hypothetical City System

thousand population. (For the smaller cities, some services, such as garbage, are provided by private contractors.)

The simulated system of Pleasantview is abstract. The decision choices in it are generalized and the simulation environment is not intended to duplicate any specific city. However, the system has been designed so that the game decisions possess many of the same fundamental characteristics found in an actual situation--that is, the Pleasantview manager is concerned with making a number of interdependent decisions in a dynamic environment in which uncertainty exists. The parametric relationships between the variables in the game reflect the hypotheses of this research.

## Departmental Parameters

Each department is described by six parameters: number of men, total budget, salary budget, non-salary budget, employee satisfaction, and level of service. In the chapter on Game Development, the functional relationships between population and departmental manpower and salaries were derived. These relationships were based on the hypothesis that the departmental sizes and average salaries vary directly with the city population. The further assumption is made that the department's level of service varies directly with the number of employees and their average salaries. Thus, low paid employees would have low morale, and the chances for poor service are high. Similarly, if a department does not have enough people, then the workload is too high, and service again will suffer. Employee satisfaction is similarly based upon the size of the department (workload) and salary level. A strike potential exists which is a function of a random variable and employee satisfaction. The city system is further described by an overall citizen satisfaction index, which is a function of all five departments' level of service and the total budget (taxes and fees). The player's decisions and the output reports form the basic game components.

## Game Components

The player is required to make decisions for the entire city and each of the departments. Based upon these decisions, output reports are generated to provide feedback to the player; this enables him to evaluate his performance.

### Input Decisions

The input decisions include the distribution of a fixed quarterly budget among the departments of the city. This budget is set by the player after he chooses the size of the city. The game allows the participant four revenue sources: sales tax, property tax, garbage fees, and utility fees. Once the quarterly budget is chosen, the player must decide how much of that budget each source provides. The player must now input the total number of employees, the salary budget, and the non-salary budget for each department. The consequences of these decisions are returned to the player in the form of output reports, and the next quarter's round of decisions can be based on these reports.

### Output Reports

The output reports provide feedback to the player and enable him to evaluate his decisions in an attempt to improve himself during the next round of decisions. Essentially, the model computes the theoretically correct values of manpower, pay, and the total revenue required to give satisfactory service for a theoretical city having the input population size. These computed values are related to those selected values to develop the parametric return equations using the procedures developed by Greenlaw (16). Two indices of performance are generated for each department: an employee satisfaction index, and a level of service index. If a strike occurs, the player is notified and warned to improve the situation during the next round of decisions. The final quarterly report provides a composite measure of the total city's satisfaction. The relationships between the input variable, internal functions and output reports are conceptually simple, but a great deal of interdependency is involved in the computation of the decision returns.

## Decision Returns

The decision returns form the basis for the output reports. These returns are generated by the parametric return curves, which are uniquely determined for each decision. Several assumptions were made in determining the output indices' functional relationships. These assumptions were based on judgement and the concept of verisimilitude. A sensitivity analysis was made to aid the game user in modifying the return curves, if desired.

### Return Curves

In this model, there are two types of relationships between the player decisions and the results of his decisions. The decision result either varies directly with the magnitude of the decision or inversely with the magnitude of the decision. However, these relationships are not linear. Thus, if a police department gives satisfactory service with 30 men, the service will not be three times as good if 90 men were on the force. Greenlaw (17) has developed methods for computing both increasing return curves and decreasing return curves.

The increasing return curve used for this model approaches a limiting return of 100 percent as the decision approaches the theoretically correct value from below. Any decision value greater than the theoretically correct value will yield a return of 100 percent. The increasing return curve takes the following general form:

$$R = D^{X_1} / (X_2 + D^{X_1}) \quad (1)$$

R = return for the decision

D = player's input decision

$$X_1 = \frac{\log (aC_1) - \log \left[ (aC_1)(1 - C_2\ C_2 \right] + \log(1 - C_4) - \log (C_4)}{\log (aC_1) - \log (aC_3)} \quad (2)$$

$$X_2 = \frac{aC_1(1-C_2)(aC_1)^{(X_1 - 1)}}{C_2} \quad (3)$$

$C_1$, $C_2$, $C_3$, $C_4$ = constants used to determine shape of curve

a = theoretically correct decision value

Figure 4 shows a typical increasing return curve where the theoretically correct decision value is 20.

The decreasing return curve approaches a limiting return of 100 percent as the decision approaches the theoretically correct value from above. Any decision value less than the theoretically correct value will yield a return of 100 percent. The decreasing return curve takes

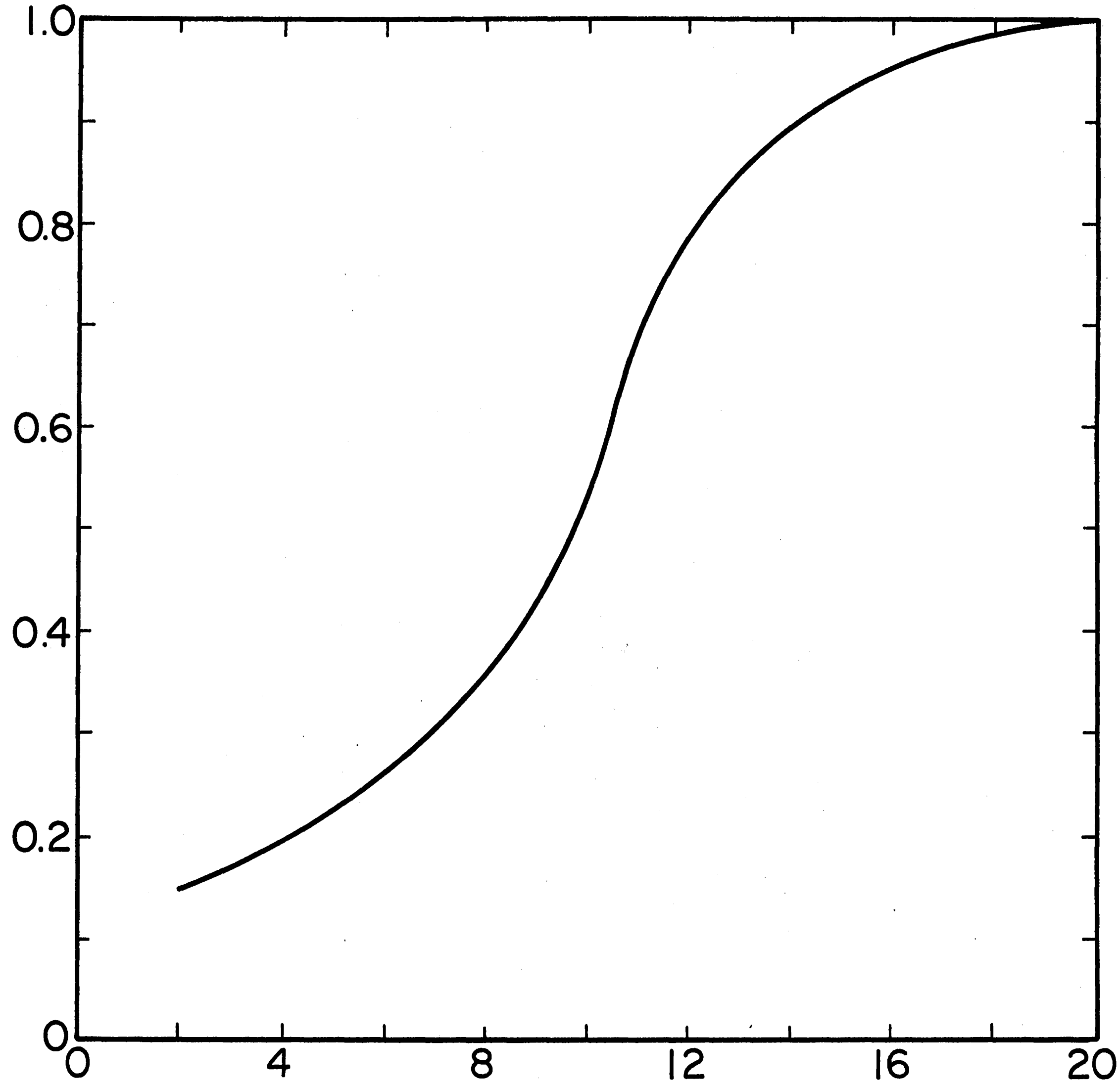


Figure 4. A Typical Increasing Return Curve

the following form:

$$R = \frac{X_2}{(X_2 + DX_1)} \qquad (4)$$

R = return for the decision

C = player's decision

$$X_1 = \frac{\log(aC_1) - \log\left[(C_2C_1a\ (1-C_2)\right] - \log\ (1-C_4) + \log\ (C_4)}{\log\ (aC_1) - \log\ (aC_3)} \qquad (5)$$

$$X_2 = \frac{C_2 \cdot C_1\ a(C_1a)^{(X_2-1)}}{(1-C_2)} \qquad (6)$$

$C_1$, $C_2$, $C_3$, $C_4$ = constants used to determine shape of curve

a = theoretically correct decision value

Figure 5 shows a typical decreasing return curve where the theoretically correct decision value is 20. The performance indices are interrelated functions of the decision returns.

Functional Relationships

The basic program flow is depicted below.

Read Population, Total Budget

↓

Compute Theoretical Values by Dept.

Number of Men

Pay

Budget

Salary Budget

↓

Read by Department

Number of Men

Budget

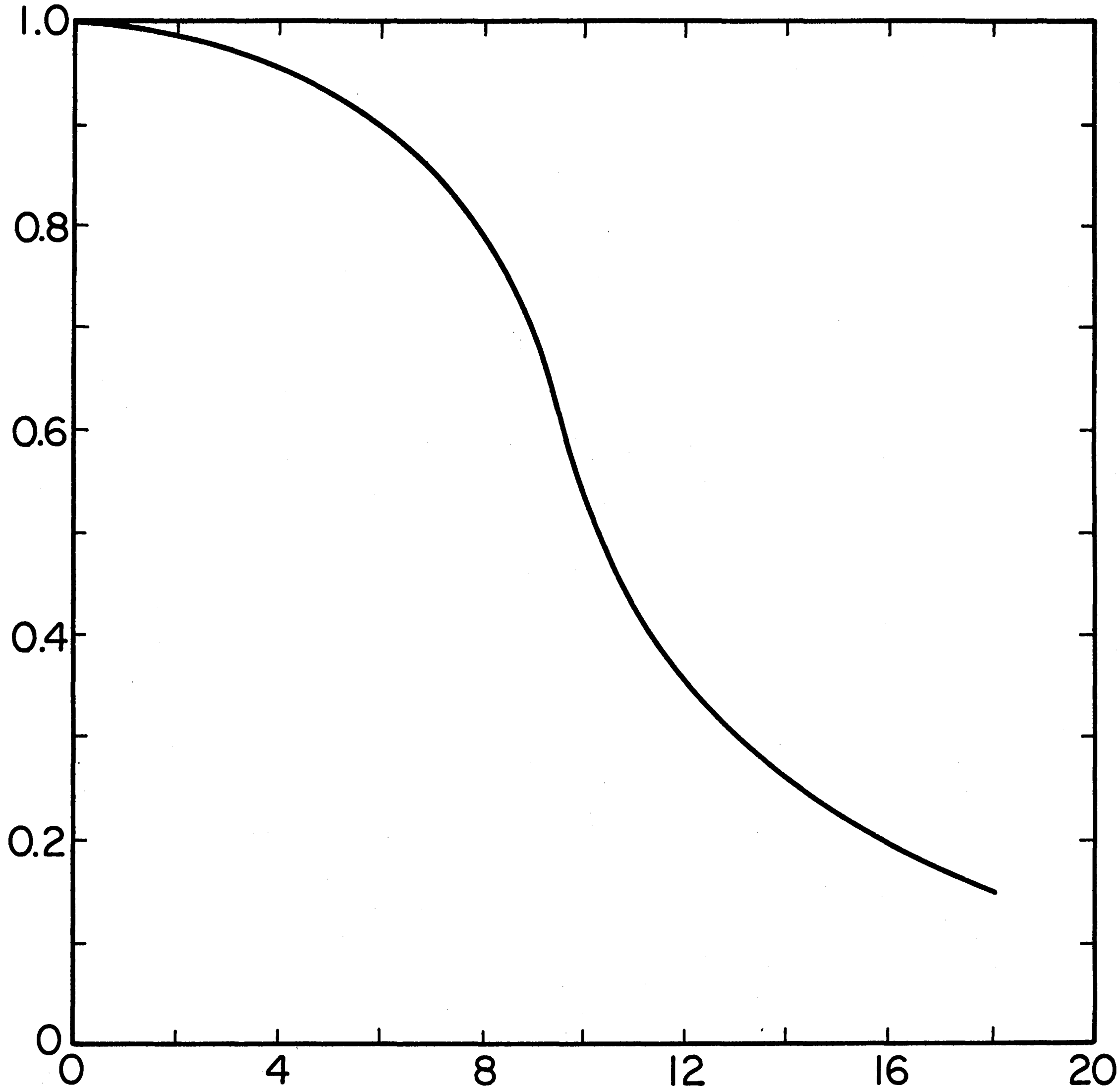


Figure 5. A Typical Decreasing Return Curve

↓

Compute Employee Satisfaction by Department

= f (# men [computed & selected]; pay

computed & selected , random variable)

↓

Compute Level of Service by Department

= (employee satisfaction, non-salary budget

[computed & selected])

↓

Determine Strike Potential

= f(employee satisfaction, random variable)

↓

Compute Overall Citizen Satisfaction

= f(weighted level of service, revenue, calculated budget)

↓

Print Reports (Performance Invoices)

Essentially, this model computes the values of manpower, pay, and total revenue required for a theoretical city having the input population size. This is done using the functions established by the analysis of the OML data (43). These computed values are related to the values selected by the participant to derive the return curves. For example, the police department for a city of 50,000 would have a computed size of 71 men and a computed average salary of $994/month. These theoretical values are assumed to result in satisfactory departmental service and, using the current game parameters, will yield an employee satisfaction index of 96. If these theoretical values are compared to various input levels of manpower and pay, and equivalent employee satisfaction index can be computed. Table III shows some typical values for this index for a fixed input pay of $800/month. In the game model, a random variable adds the unpredictable element so common in dealing with human organizations. The employee satisfaction index is of the following general form:

$$EMPID = R_V\ (.4R_1 + .6R_2) \qquad (7)$$

where

EMPID = Employee Satisfaction Index

$R_V$ = Random Variable ($.6 \leq R_V \leq 1.0$)

$R_1$ = return on selected Department Manpower

$R_2$ = return on selected Department Average Salaries

TABLE III

EMPLOYEE SATISFACTION VERSUS PAY AND MANPOWER FOR A CITY OF 50,000

| | Pay = $800/month |
|---|---|
| Number of Men | Employee Satisfaction Index |
| 10 | 54 |
| 20 | 57 |
| 30 | 66 |
| 40 | 79 |
| 50 | 87 |
| 60 | 91 |
| 70 | 92 |
| 80 | 93 |
| 90 | 94 |

The weights of .4 and .6 were chosen on the assumption that pay is more important than workload in a measure of employee satisfaction.

The level of service index is assumed to be a function of the employee satisfaction index and the money allocated to departmental overhead. Thus

$$LEVSERV = .75 \cdot EMPID + .25 \cdot RO \qquad (8)$$

LEVSERV = Level of service

RO = Return on selected departmental overhead

EMPID = Employee satisfaction index

The department overhead or non-salary budget is the source of money used for the necessary equipment used by the department. Therefore, the amount of money allotted to overhead should have an effect upon the department's service to the public. The employee satisfaction index is a measure of employee morale and should also have an effect on the service. In this model, it is assumed that employee satisfaction will have a much greater effect upon service than equipment or hardware. The rationale is that most city services are labor intensive. The city's total satisfaction index combines all of the department level of service indices with a return on the selected budget decision. Initially, a theoretically correct budget is computed. The correct city budget is simply assumed to be double the sum of all the departments' computed salary budget (see Appendix C). The city budget's return is computed using a decreasing returns curve; the logic being that the higher taxes and fees are, the lower the citizen's satisfaction will be. The city's total satisfaction index is

$$\begin{aligned} CITDX = {} & .4\ (.20\left[\text{Police Service Level}\right] + .20\left[\text{Fire Service Level}\right] \\ & + .25\left[\text{Parks and Streets Service Level}\right] + .25\left[\text{Garbage Service Level}\right] + .1\left[\text{Utilities Service Level}\right]) + .6\ R1 \qquad (9) \end{aligned}$$

CITDX = Total city's satisfaction

R1 = Return on the selected city budget

The departmental weighting factors were chosen on the basis of exposure. Thus, in the long run, the average citizen is more exposed to street conditions and garbage collection service than to police service, fire protection, or utilities variation. The return on the selected city budget is inversely proportional to the general citizen costs of city services. Since this return is a function of taxes and fees, it is given a weight of .6 versus the weight of .4 for departmental service levels. The returns are a function of several variables, and a sensitivity analysis should prove helpful to the game user.

## Sensitivity Analysis

Sometimes the administrator of a game finds it convenient to change the sensitivity of the model. In other words, he may want to vary the performance indices for a set of input decisions. To change the returns for a given set of input decisions, it is necessary to change the shape of the returns curve. The shape of the returns curve is uniquely determined by the four constants, $C_1$, $C_2$, $C_3$, and $C_4$. A sensitivity analysis was performed by varying all four of these constants simultaneously through three values. Each variable was varied from a low to an intermediate to a high value in an effort to determine which variable, if any, had the greatest effect upon the returns curve. The variables were determined to be $C_1$ for the decreasing returns curve and $C_3$ for the increasing returns curve.

Figure 6 shows the relationship of the constants to the decreasing

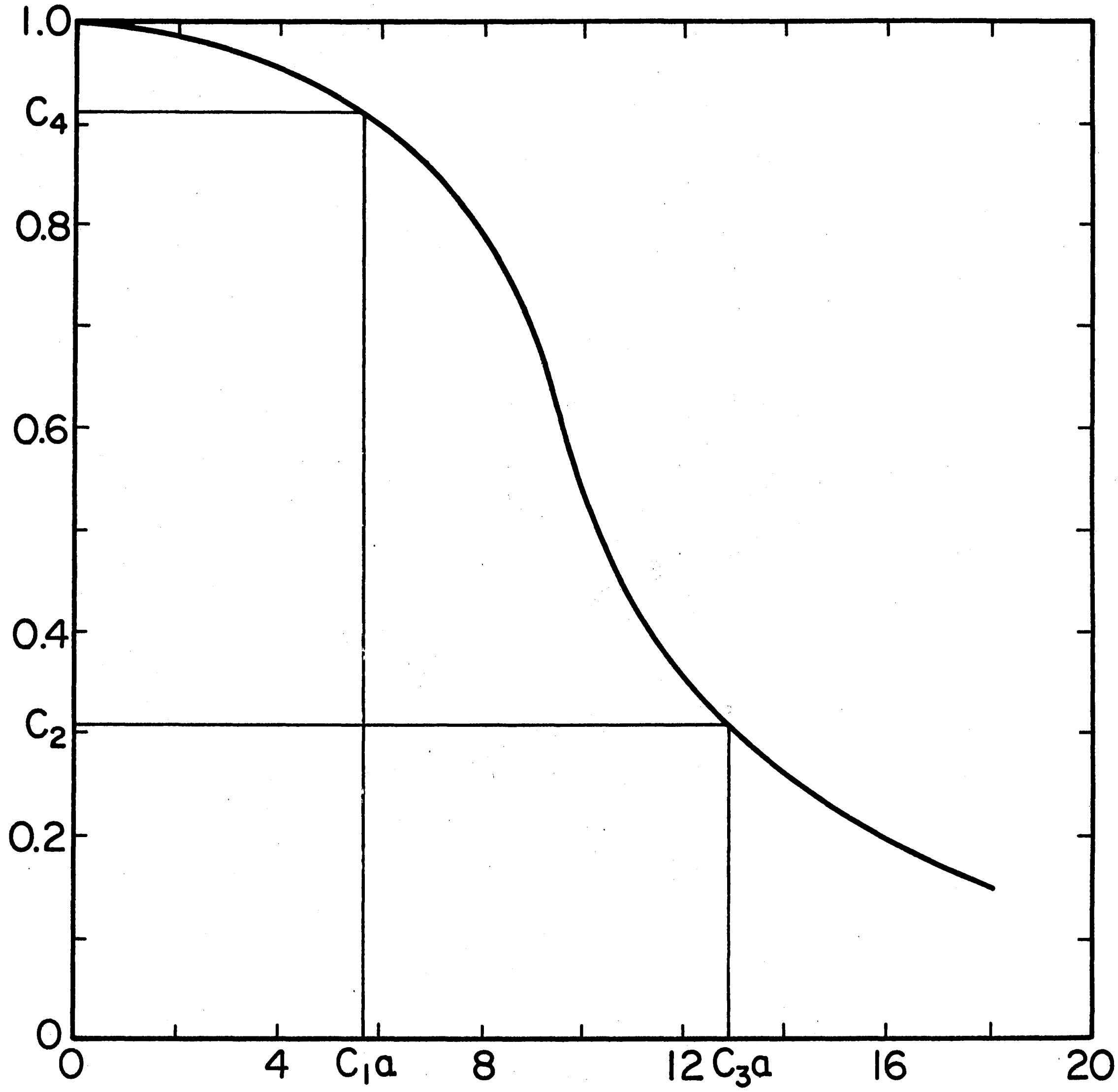


Figure 6. The Relationship of the Curve Shaping Constants ($C_1$, $C_2$, $C_3$, $C_4$) to the Decreasing Returns Curve

returns curve where the constant a is the theoretically correct decision. For normal play, a recommended set of values for the constants is:

$$C_1 = 1.7$$
$$C_2 = .1$$
$$C_3 = 1.3$$
$$C_4 = .9$$

Table IV shows the sensitivity of the decreasing returns curve to the constant $C_1$. The body of the table shows the decision returns for three decisions. The theoretically correct value is a. As the decisions increase, the returns decrease. Column one shows the returns for a recommended set of constant values. Figure 7 shows the relationship of the constants to the increasing returns curve. Again, the constant a is the theoretically correct decision. A recommended set of values for these constants is:

$$C_1 = .1$$
$$C_2 = .01$$
$$C_3 = .9$$
$$C_4 = .9$$

Table V shows the sensitivity of the increasing returns curve to the constant $C_3$. As the decisions increase, the returns increase. Column three shows the returns for a recommended set of constants.

A summary of this research points out some helpful recommendations to the researcher interested in gaming as an educational tool in the public sector.

TABLE IV

SENSITIVITY OF THE DECREASING RETURNS CURVE TO THE CONSTANT $C_1$

| Decision \ $C_1$ | 1.7 | 2.2 | 2.7 |
|---|---|---|---|
| a | 99 | 99 | 98 |
| 1.5a | 46 | 73 | 79 |
| 2.0a | 1 | 20 | 40 |

$C_2 = .1$ $C_3 = 1.3$ $C_4 = .9$

TABLE V

SENSITIVITY OF THE INCREASING RETURNS CURVE TO THE CONSTANT $C_3$

| Decision \ $C_3$ | .4 | .7 | .9 |
|---|---|---|---|
| a | 100 | 98 | 93 |
| .75a | 99 | 94 | 84 |
| .50a | 96 | 78 | 59 |

$C_1 = .1$ $C_2 = .01$ $C_4 = .9$

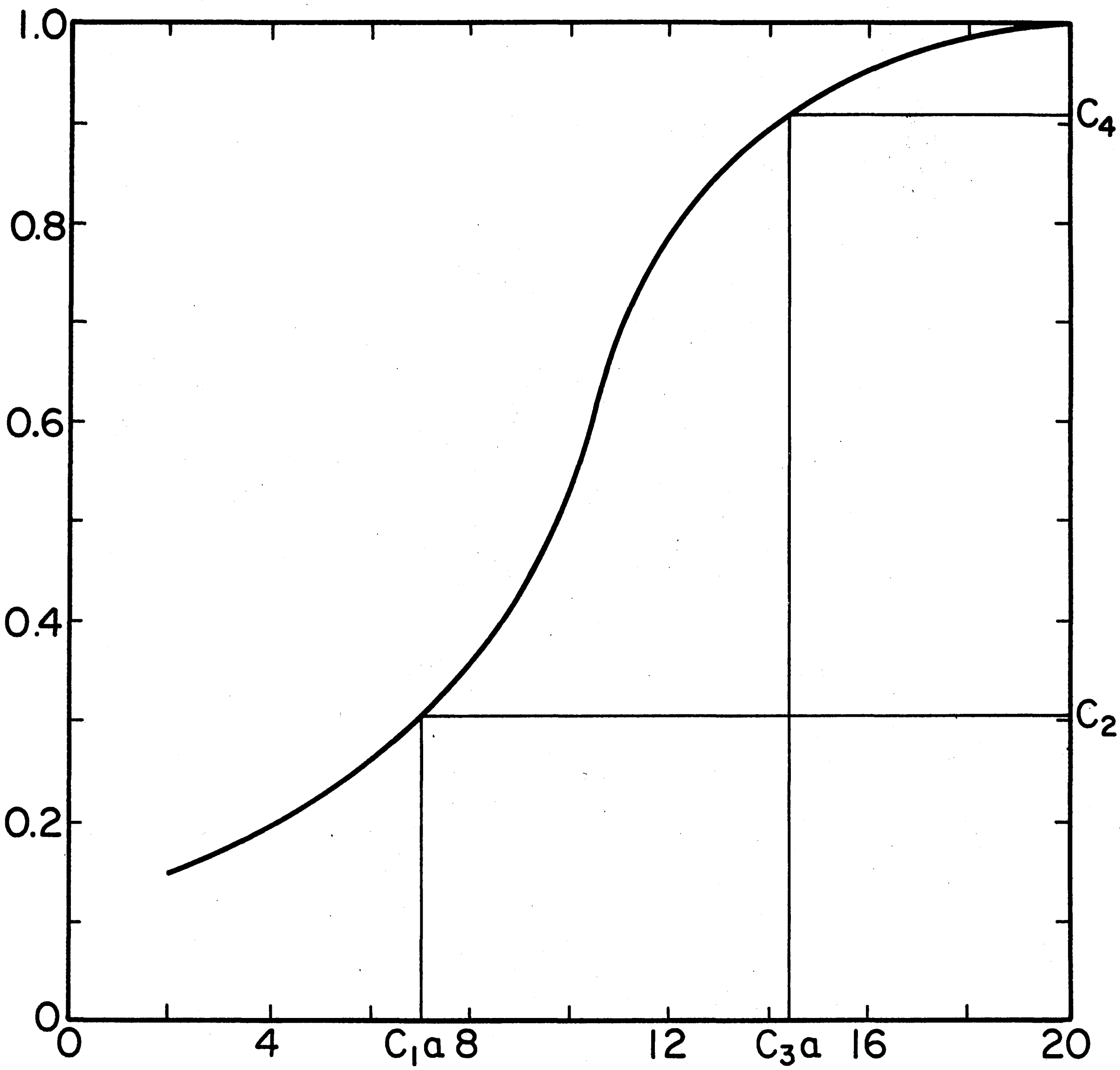


Figure 7. The Relationship of the Curve Shaping Constants ($C_1$, $C_2$, $C_3$, $C_4$) to the Increasing Returns Curve

# CHAPTER V

# CONCLUSIONS AND RECOMMENDATIONS

A suitable model for a city manager's management game was developed. The functional relationships between the input decisions and the output results were established. Further research into the city system should provide insight in developing a more generalized game.

## Conclusions

The objective of this research was to develop a management game for city administrators. A city systems model which described the basic resource allocation problems faced by a city manager preceded the game's development. Functional relationships between the decision inputs for each city department and the size of the city were established. These decision inputs were: total city budget, number of employees and salary, and non-salary budgets for the city departments. The research analysis showed that as city populations increased, both average salaries and department sizes increased. Further, these decision variables were related to both the level of service given by each department and the departmental employee satisfaction. A relationship was formed between total city input and citizen satisfaction. A survey of the literature helped to define the basic components of an operational game. Further research into the city model development of a more comprehensive game is recommended.

## Recommendations

The operational model developed illustrated the city manager's important function of scarce resource allocation. Further research could be done to expand the game, function by function, to incorporate more general training. Another approach for future researchers might be to expand the game to allow for several players assuming different administrative roles simultaneously.

Simulation games such as this one are often considered the first step in the building of a predictive, problem-solving model. Thus, this game could be considered a model of a model.

Chapter IV described many assumptions that were incorporated in the game's model. These assumptions were logical, but future research should attempt to verify them in a more quantitative manner.

A SELECTED BIBLIOGRAPHY


(1) Abt, Clark C. Serious Games. New York: The Viking Press, 1970.

(2) Barton, R. S. A Primer on Simulation and Gaming. New York: Prentice-Hall, 1970.

(3) Belch, Jean. Contemporary Games, A Directory and Bibliography. Detroit: Gale Research Company, 1973, pp. 8-10.

(4) Bellman, R. "On the Construction of a Multi-person, Multi-stage Business Game." Operations Research (August, 1957), pp. 469-503.

(5) Bonini, Charles P. Simulation of Information and Decisions Systems in the Firm. Chicago: Marklan Publishing Company, 1967.

(6) Boocock, Sarane S., and E. D. Schild (Eds.). Simulation Games in Learning. Beverly Hills, California: Sage Publications, 1968, p. 8.

(7) Carlson, John G. Introduction to Gaming. New York: John Wiley, 1972.

(8) Chadwick, George F. A Systems View of Planning; Tanarasa Theory of the Urban and Regional Planning Process. New York, Oxford: Pergamon Press, 1971.

(9) Churchman, Charles West. The Systems Approach. New York: Delacorte Press, 1968.

(10) Cohen, Kahlman, and Eric Rhenman. "The Role of Management Games in Education and Research." Management Science, Vol. 7, No. 2 (January, 1961), pp. 131-166.

(11) Davis, Morton D. Game Theory, A Non-technical Introduction. New York: Basic Books, 1970.

(12) Duke, R. D. Gaming Simulation in Urban Research. Michigan State University: Continuing Education Service, 1964.

(13) Eilon, S. "Management Games." Operations Research (June, 1963) pp. 137-149.

(14) Fitzgerald, John M. Fundamentals of System Analysis. New York: John Wiley, 1973.

(15) Graham, Robert G. Business Games Handbook. New York: American Management Association, 1969.

(16) Greenlaw, P. S. "Designing Parametric Equations for Business Games." Academy of Management Journal (June, 1963), pp. 150-159.

(17) Greenlaw, P. S., L. W. Herron, and R. N. Rawoon. Business Simulation in Industrial and University Education. New York: Prentice-Hall, 1962, pp. 5, 271-273.

(18) Hausrath, Alfred Hartman. Venture Simulation in War, Business, and Politics. New York: McGraw-Hill, 1971.

(19) Herzberg, Frederick. Work and the Nature of Man. Cleveland: The World Publishing Company, Chapters VII and VIII, 1966.

(20) Kibbee, Joel M., Clifford J. Craft, and Burt Nanus. Management Games. New York: Rheinhold, 1961, pp. 100-102.

(21) Hoos, Ida Russakoff. Systems Analysis in Public Policy. Berkeley: University of California Press, 1972.

(22) Laska, Richard M. "City Models Challenge Urban Managers." Computer Decisions (February, 1972), p. 15.

(23) Livermore, W. R., Major. The American Krieggspiel, A Game for Practicing the Art of War Upon a Topographical Map. Boston: W. B. Clark, 1898.

(24) Lowry, I. S. A Model of Metropolis. Santa Monica: Rand Corporation, 1964.

(25) Mesarovic, M. D., and A. Reisman (Eds.). Systems Approach and the City. New York: American Elsevier Publishing Company, 1970.

(26) McKenney, J. L. Simulation Gaming for Management Development. Boston: Harvard University Graduate School of Business, 1967, p. 15.

(27) Mize, J. H., and J. G. Cox. Essentials of Simulation. Englewood Cliffs, New Jersey: Prentice-Hall, 1968.

(28) Nadler, Gerald. Work Systems Design: The Ideals Concept. New York: R. D. Irwin, Inc., 1967.

(29) Optner, S. L. Systems Analysis for Business Management. Englewood Cliffs, New Jersey: Prentice-Hall, 1968.

(30) Pfiffner, J. M., and R. V. Presthus. Public Administration. New York: Ronald Press, 1953.

(31) Rosenbloom, R. S. New Tools for Urban Management, Case Studies. Boston: Harvard University Press, 1971.

(32) Schrieber, A. N. "The Theory and Application of the Management Game to Teaching Business Policy." Journal of the Academy of Management, Vol. 1 (August, 1958), p. 1-10.

(33) Shubik, M., G. Brewer, and E. Savage. The Literature of Gaming Simulation and Model Building: Index and Critical Abstracts. Santa Monica: Rand Corporation, 1972.

(34) Steine, E. D. The City Manager: Professional Training and Tenure. Lawrence, Kansas: The University of Kansas Publications, Governmental Research Series No. 34, 1966.

(35) Tansey, P. J., and Derick Unwin. Simulation and Gaming in Education. London: Methuen Educational, Ltd., 1969.

(36) Taylor, John L. Instructional Planning Systems: A Gaming-Simulation Approach to Urban Problems. London: Cambridge University Press, 1971, pp. 10-15.

(37) Totten, Charles A. L. Strategos: A Series of American Games of War. New York: D. Appleton and Company, 1880, p. VII.

(38) Wildavsky, Aaron. Leadership in a Small Town. Totowa, New Jersey: The Bedminster Press, 1964.

(39) Zoll, Allen A. 3rd. Dynamic Management Education. Reading, Massachusetts: Addison-Wesley, 1969, p. 370.

(40) Zuckerman, D. W., and R. E. Horn. The Guide to Simulation/Games for Education and Training. Lexington, Massachusetts: Information Resources, Inc., 1973, pp. 257-268.

(41) FBI Annual Report. Washington, D. C.: U. S. Government Printing Office, 1973, pp. 200-202.

(42) The 1974 Municipal Yearbook. Washington, D. C.: The International City Management Association, 1974.

(43) 1974 Salaries, Wages and Fringe Benefits of Oklahoma Cities and Towns. Oklahoma City: The Oklahoma Municipal League, 1974, pp. 1-88.

APPENDIX A

SUMMARY OF OF OKLAHOMA MUNICIPAL LEAGUE DATA

The Oklahoma Municipal League conducts an annual wage and salary survey of all cities and towns in Oklahoma. With the exception of some of the salary data, the data used in this research did not include cities under the population of 5,000. The two cities in Oklahoma with populations over 100,000 were also omitted. These omissions left a total of 59 cities included in the data base. The salary survey lists 22 different job classifications. Only ten of these were used in the game, and they were combined to form the five departments as shown in Table VI. Tables VII through XI show the raw data that was used to draw the scatter diagrams for number of employees versus population. Figures 8 through 12 show scatter diagrams and the resultant regressed curve for each department. In relating the number of employees to population, each point represents a city. Relating the average salary level to population size was a somewhat different problem, since the salary data was for individuals, and thus involved hundreds of points. In order to obtain a trend line, three populations were defined, representing low (3,500-6,499), medium (16,500-23,499), and high (26,500-33,499) population groups. For each department in each population group, a weighted average salary was obtained using a salary cell interval of 50. Tables XII through XIV show the salary frequencies for the three population groups.

The sample calculation below for cities grouped between 3,500 and 6,499 yields the average salary for the police department:

$$(2x225 + 2x325 + 36x375 + 52x425 + 68x475 + 24x525 + 10x575 + 7x625 + 4x675 + 2x725 + 2x775 + 825)/210 = \$468/\text{month}$$

The number used as the average salary was $468 for a population of 5,000. The other points were computed similarly for each population range.

TABLE VI

RELATION OF MODEL CITY DEPARTMENTS AND OML JOB CLASSIFICATIONS

| Pleasantview Department | OML Job Classification |
|---|---|
| Police | Police - Commissioned<br>Police - Non-commissioned |
| Fire | Fire |
| Parks and Streets | Parks and Recreation<br>Street |
| Garbage | Sanitation |
| Utilities | General Public Works<br>Water<br>Sewer<br>Electric |

After the scatter diagrams were drawn, a definite upward trend was noted, and a straight line regression analysis was performed. An analytical regression analysis was used to determine the relationships between number of employees and population for each department. For the salary curves, a slightly different approach was used, since only three points were involved. The regression line was hand-fitted and the slope-intercept method was used to determine the parameters for each line. As an example, from Figure 13:

(1) $X_1 = 0 \quad Y_1 = 450$

(2) $X_2 = 22.5 \quad Y_2 = 695$

(3) $Y = mX + b$

(4) $b = 450$

Substituting (2) and (4) into (3) yields

$$m = \frac{245}{22.5} = 10.89$$

and

$$Y = 10.89 \cdot X + 450$$

where

$$Y = \text{average monthly salary}$$

$$X = \text{population} \div 1000$$

Similar computations yielded the rest of the parametric equations relating population and pay. Figures 13 through 17 show the scatter diagrams and the regressed lines relating population and average monthly salary.

TABLE VII

NUMBER OF POLICE DEPARTMENT EMPLOYEES FOR SELECTED CITIES WITH POPULATIONS FROM 5,000 TO 74,000

| Number of Employees for Each City Within the Population Group | |
|---|---|
| 5,000 | 8, 6, 11, 7 |
| 6,000 | 8, 12, 10 |
| 7,000 | 18, 15 |
| 8,000 | 14, 15, 12, 16 |
| 9,000 | 19, 17, 18, 16 |
| 10,000 | 10, 23, 18, 19 |
| 11,000 | 16 |
| 12,000 | 20 |
| 14,000 | 28, 29, 17 |
| 15,000 | 29, 23, 28 |
| 17,000 | 23 |
| 19,000 | 33, 26 |
| 20,000 | 37 |
| 22,000 | 25, 38 |
| 23,000 | 34, 41 |
| 25,000 | 41 |
| 26,000 | 48 |
| 27,000 | 23 |
| 30,000 | 42 |
| 31,000 | 39 |
| 37,000 | 72 |
| 45,000 | 53 |
| 48,000 | 61 |
| 52,000 | 71 |
| 74,000 | 111 |

TABLE VIII

NUMBER OF FIRE DEPARTMENT EMPLOYEES FOR SELECTED CITIES WITH POPULATIONS FROM 5,000 TO 74,000

| Number of Employees for Each City Within the Population Group | |
|---|---|
| 5,000 | 5, 7 |
| 6,000 | 7, 10, 15, 9, 8 |
| 7,000 | 8, 1, 6, 24 |
| 8,000 | 13, 11, 10, 3, 5, 19 |
| 9,000 | 10, 18, 17 |
| 10,000 | 5, 14, 10, 7 |
| 11,000 | 26 |
| 12,000 | 13 |
| 14,000 | 13, 29, 27 |
| 15,000 | 25, 16, 23 |
| 17,000 | 21 |
| 19,000 | 26, 24 |
| 20,000 | 31 |
| 22,000 | 42, 24 |
| 23,000 | 28, 13 |
| 25,000 | 46 |
| 26,000 | 60 |
| 27,000 | 25 |
| 30,000 | 46 |
| 31,000 | 37 |
| 37,000 | 73 |
| 45,000 | 71 |
| 48,000 | 72 |
| 52,000 | 61 |
| 74,000 | 94 |

TABLE IX

NUMBER OF PARKS AND STREETS DEPARTMENT EMPLOYEES FOR SELECTED CITIES WITH POPULATIONS FROM 5,000 TO 74,000

| Number of Employees for Each City Within the Population Group | |
|---|---|
| 5,000 | 1, 5, 2, 3 |
| 6,000 | 3, 2, 12, 7, 4 |
| 7,000 | 9, 19, 9 |
| 8,000 | 5, 6, 7, 10 |
| 9,000 | 8, 2, 4, 6 |
| 10,000 | 4, 1, 5 |
| 11,000 | 4 |
| 12,000 | 2 |
| 14,000 | 2, 5, 12 |
| 15,000 | 2, 8 |
| 17,000 | 13 |
| 19,000 | 5, 3 |
| 20,000 | 11 |
| 22,000 | 10, 12 |
| 23,000 | 8, 10 |
| 25,000 | 7 |
| 26,000 | 35 |
| 27,000 | 6 |
| 30,000 | 12 |
| 31,000 | 9 |
| 37,000 | 21 |
| 45,000 | 30 |
| 48,000 | 13 |
| 52,000 | 18 |
| 74,000 | 3 |

TABLE X

NUMBER OF GARBAGE DEPARTMENT EMPLOYEES FOR SELECTED CITIES WITH POPULATIONS FROM 5,000 TO 74,000

| Number of Employees for Each City Within the Population Group | |
|---|---|
| 5,000 | 6, 2, 4, 7 |
| 6,000 | 13, 4, 6, 10 |
| 7,000 | 10, 2, 7, 19, 9 |
| 8,000 | 13, 15, 11, 12, 15 |
| 9,000 | 10, 12, 14 |
| 10,000 | 16, 13, 18 |
| 11,000 | 22 |
| 12,000 | 13 |
| 14,000 | 17, 28, 15 |
| 15,000 | 16, 18, 24 |
| 17,000 | 27 |
| 19,000 | 27 |
| 20,000 | 25 |
| 22,000 | 37, 28 |
| 23,000 | 17, 18 |
| 25,000 | 2 |
| 26,000 | 33 |
| 27,000 | 31 |
| 30,000 | 40 |
| 31,000 | 32 |
| 37,000 | 39 |
| 45,000 | 59 |
| 48,000 | 52 |
| 52,000 | 42 |
| 74,000 | 30 |

TABLE XI

NUMBER OF UTILITIES DEPARTMENT EMPLOYEES FOR SELECTED CITIES WITH POPULATIONS FROM 5,000 TO 74,000

| Number of Employees for Each City Within the Population Group | |
|---|---|
| 5,000 | 11, 13, 20, 9, 6 |
| 6,000 | 14, 11, 7, 19, 16, 25, 21 |
| 7,000 | 13, 16, 15 |
| 8,000 | 30, 46, 10, 13, 20, 26 |
| 9,000 | 17, 21, 6, 33 |
| 10,000 | 15, 8, 9, 11 |
| 11,000 | 20 |
| 12,000 | 31 |
| 14,000 | 4, 45, 39 |
| 15,000 | 60, 33, 31 |
| 17,000 | 50 |
| 19,000 | 67, 21 |
| 20,000 | 57 |
| 22,000 | 64, 50 |
| 23,000 | 27, 37 |
| 25,000 | 32 |
| 26,000 | 75 |
| 27,000 | 51 |
| 30,000 | 61 |
| 31,000 | 66 |
| 37,000 | 89 |
| 45,000 | 101 |
| 48,000 | 89 |
| 52,000 | 57 |
| 74,000 | 84 |

TABLE XII

NUMBER OF EMPLOYEES IN SALARY RANGE BY DEPARTMENT FOR CITIES GROUPED IN POPULATIONS OF 3,500 TO 6,499

| Average Monthly Salary ($) | Police | Fire | Parks and Streets | Garbage | Utilities |
|---|---|---|---|---|---|
| 0- 99 | | | | | |
| 100-149 | | 2 | | | 1 |
| 150-199 | | 1 | 1 | | 0 |
| 200-249 | 2 | 1 | 4 | | 5 |
| 250-299 | 0 | 0 | 1 | | 3 |
| 300-349 | 2 | 0 | 1 | 15 | 9 |
| 350-399 | 36 | 0 | 30 | 28 | 53 |
| 400-449 | 52 | 49 | 25 | 27 | 69 |
| 450-499 | 68 | 17 | 10 | 37 | 53 |
| 500-549 | 24 | 54 | 9 | 6 | 22 |
| 550-599 | 10 | 3 | 7 | 3 | 7 |
| 600-649 | 7 | 3 | 1 | 0 | 5 |
| 650-699 | 4 | 2 | 3 | 1 | 1 |
| 700-749 | 2 | 3 | 2 | | 2 |
| 750-799 | 2 | 1 | 2 | | 1 |
| 800-849 | 1 | | 0 | | 0 |
| 850-899 | | | 1 | | 0 |
| 900-949 | | | | | 0 |
| 950-999 | | | | | 1 |
| 1000-1049 | | | | | 1 |

TABLE XIII

NUMBER OF EMPLOYEES IN SALARY RANGE BY DEPARTMENT FOR CITIES GROUPED IN POPULATIONS OF 16,500 TO 23,499

| Average Monthly Salary ($) | Police | Fire | Parks and Streets | Garbage | Utilities |
|---|---|---|---|---|---|
| 0- 99 | | | | | |
| 100-149 | | | | | |
| 150-199 | 4 | | | | |
| 200-249 | 2 | | | | |
| 250-299 | 1 | | 5 | 21 | |
| 300-349 | 2 | | 0 | 0 | |
| 350-399 | 9 | | 0 | 0 | 1 |
| 400-449 | 13 | | 17 | 58 | 54 |
| 450-499 | 8 | 49 | 19 | 34 | 121 |
| 500-549 | 74 | 42 | 10 | 62 | 68 |
| 550-599 | 52 | 34 | 4 | 24 | 29 |
| 600-649 | 55 | 15 | 3 | 7 | 21 |
| 650-699 | 31 | 20 | 1 | 2 | 11 |
| 700-749 | 14 | 27 | 2 | 5 | 5 |
| 750-799 | 18 | 14 | 4 | 3 | 5 |
| 800-849 | 2 | 2 | 3 | 2 | 7 |
| 850-899 | 3 | 3 | 0 | 1 | 1 |
| 900-949 | 1 | 0 | 0 | 1 | 2 |
| 950-999 | 0 | 1 | 3 | 1 | 1 |
| 1000-1049 | 3 | 1 | 0 | 0 | 1 |
| 1050 up | 4 | 1 | 1 | 2 | 2 |

TABLE XIV

NUMBER OF EMPLOYEES IN SALARY RANGE BY DEPARTMENT FOR CITIES GROUPED IN POPULATIONS OF 26,500 TO 33,499

| Average Monthly Salary ($) | Police | Fire | Parks and Streets | Garbage | Utilities |
|---|---|---|---|---|---|
| 0- 99 | | | | | |
| 100-149 | | | | | |
| 150-199 | 4 | | | | |
| 200-249 | 0 | | 1 | | |
| 250-299 | 0 | | 0 | | 22 |
| 300-349 | 0 | | 1 | | 0 |
| 350-399 | 0 | | 2 | | 1 |
| 400-449 | 3 | 1 | 4 | | 29 |
| 450-499 | 5 | 0 | 25 | 97 | 31 |
| 500-549 | 26 | 43 | 3 | 13 | 35 |
| 550-599 | 23 | 11 | 5 | 29 | 62 |
| 600-649 | 73 | 52 | 6 | 2 | 19 |
| 650-699 | 17 | 24 | 9 | 0 | 9 |
| 700-749 | 14 | 35 | 2 | 1 | 8 |
| 750-799 | 2 | 5 | 0 | 1 | 2 |
| 800-849 | 6 | 15 | 2 | 1 | 6 |
| 850-899 | 1 | 0 | 15 | 1 | 1 |
| 900-949 | 4 | 5 | 0 | 0 | 3 |
| 950-999 | 0 | 0 | 2 | 1 | 0 |
| 1000-1049 | 0 | 1 | 2 | | 0 |
| 1050-1099 | 1 | 1 | 0 | | 0 |
| 1100-1149 | 1 | 1 | | | 0 |
| 1150-1199 | 0 | 0 | | | 1 |
| 1200-1249 | 0 | 0 | | | 1 |
| 1250-1299 | 2 | 1 | | | 0 |
| 1300 up | | | | | 2 |

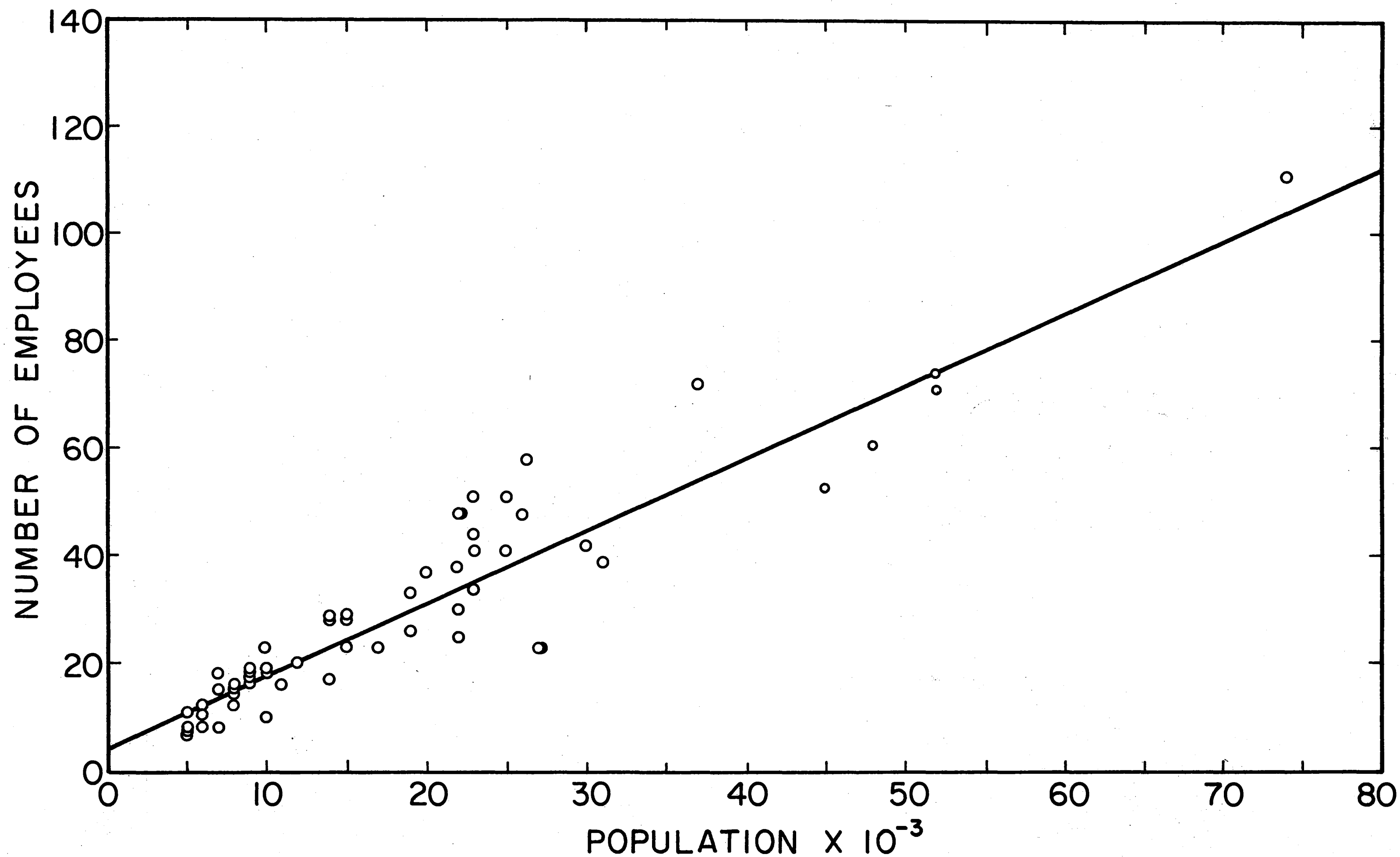


Figure 8. Number of Police Department Employees versus Population X $10^{-3}$

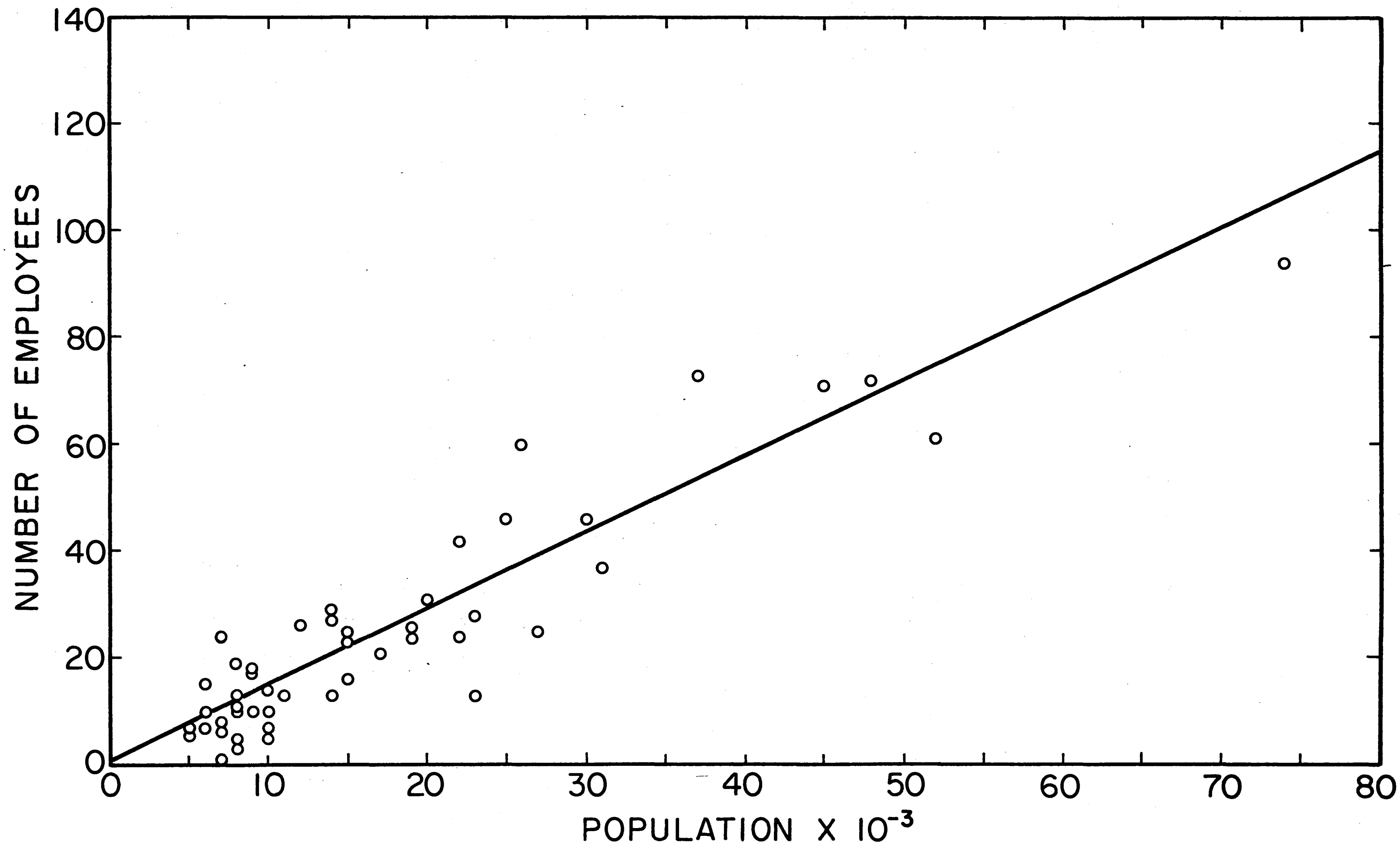


Figure 9. Number of Fire Department Employees versus Population X $10^{-3}$

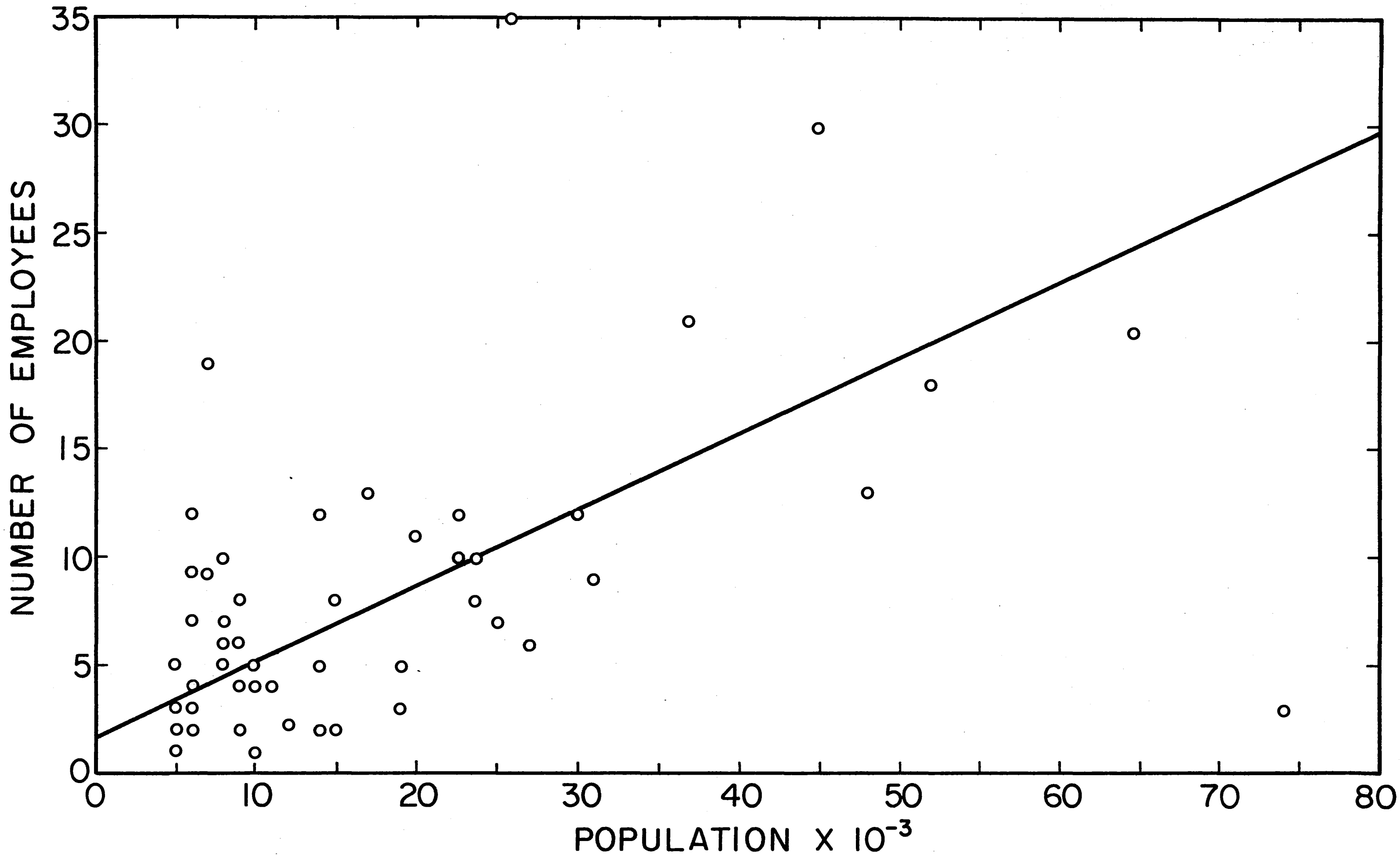


Figure 10. Number of Parks and Streets Department Employees versus Population X $10^{-3}$

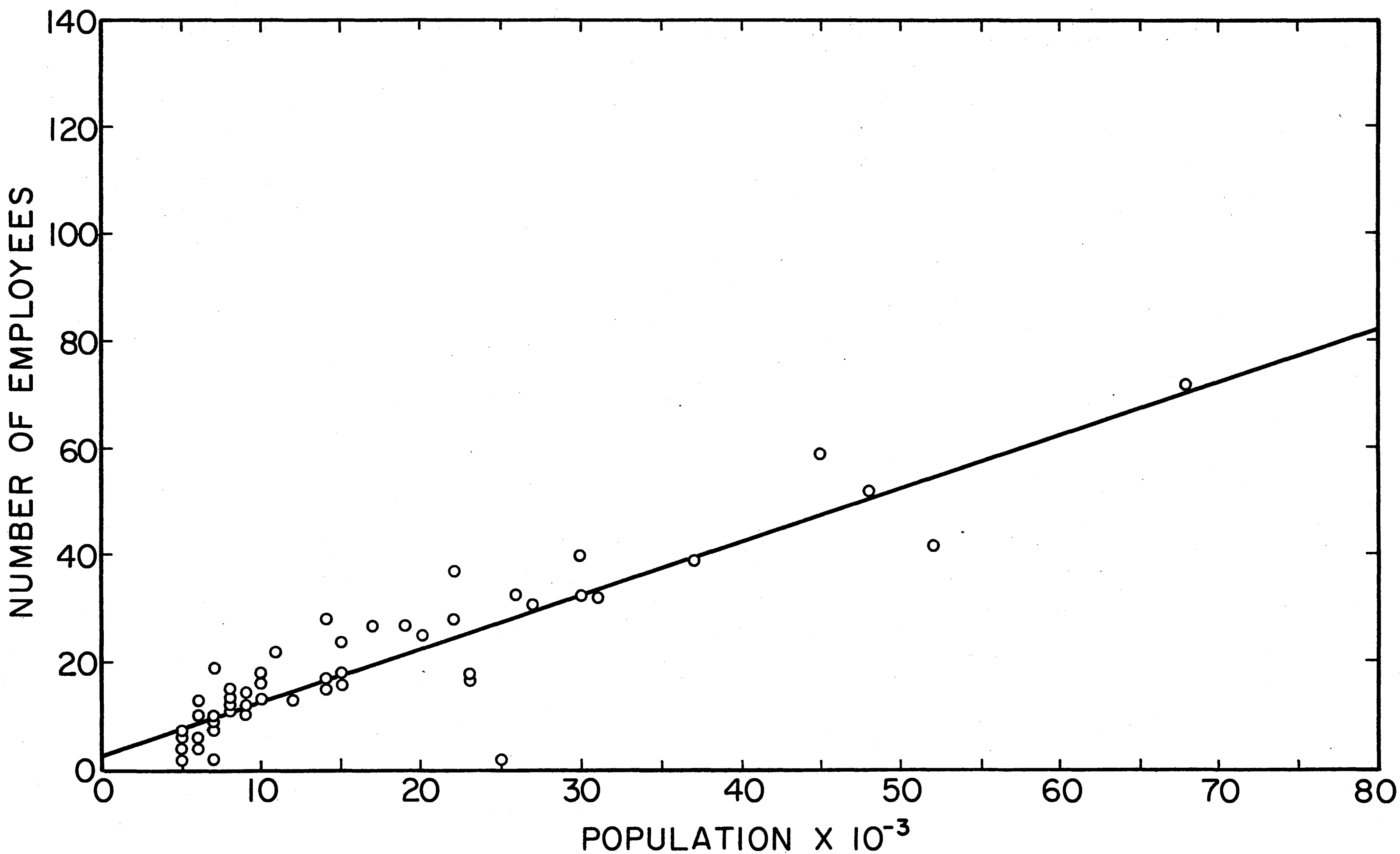


Figure 11. Number of Garbage Department Employees versus Population X $10^{-3}$

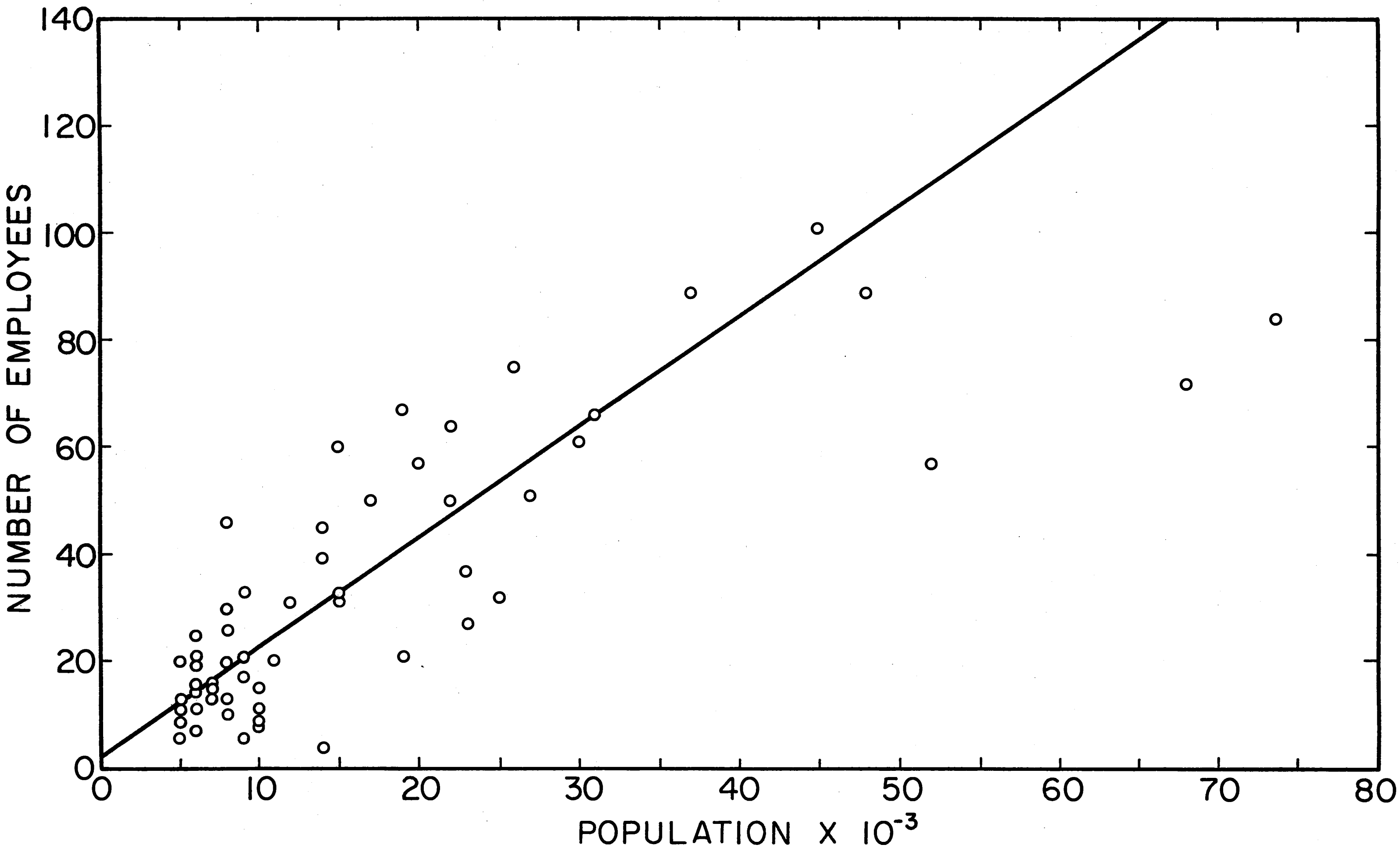


Figure 12. Number of Utilities Department Employees versus Population X $10^{-3}$

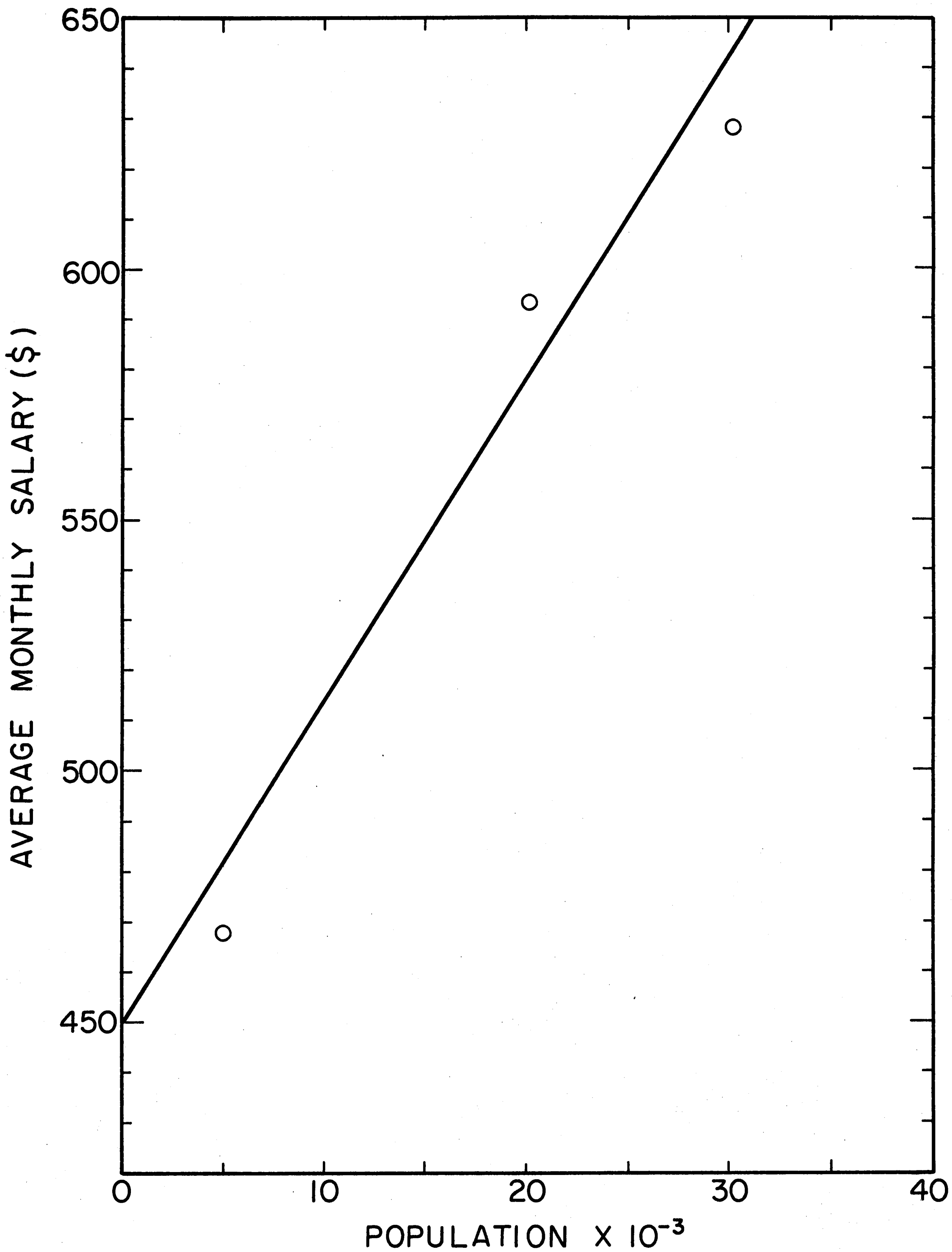


Figure 13. Average Monthly Salary for Police Department Employees in Selected Cities

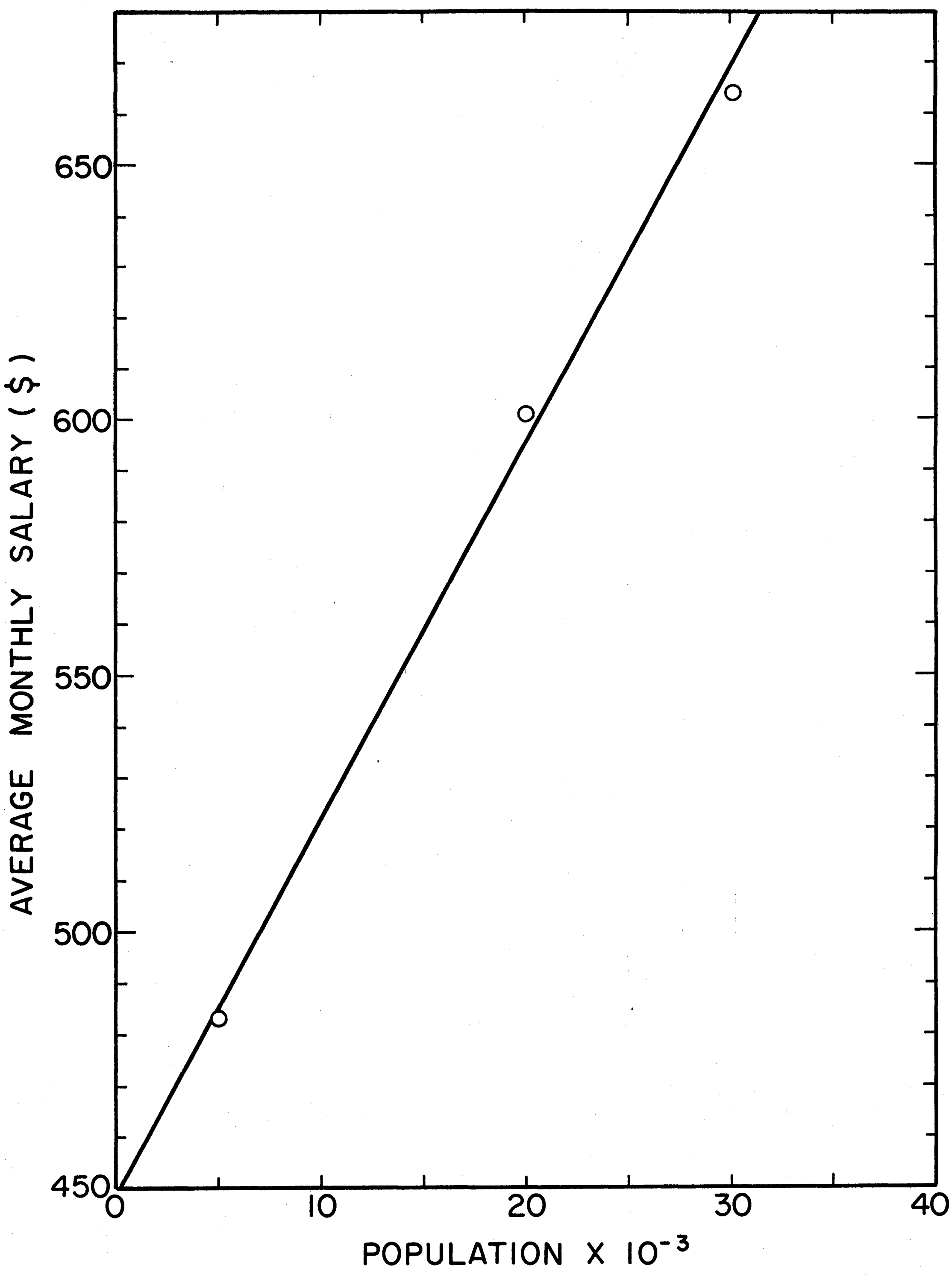


Figure 14. Average Monthly Salary for Fire Department Employees versus Population X $10^{-3}$

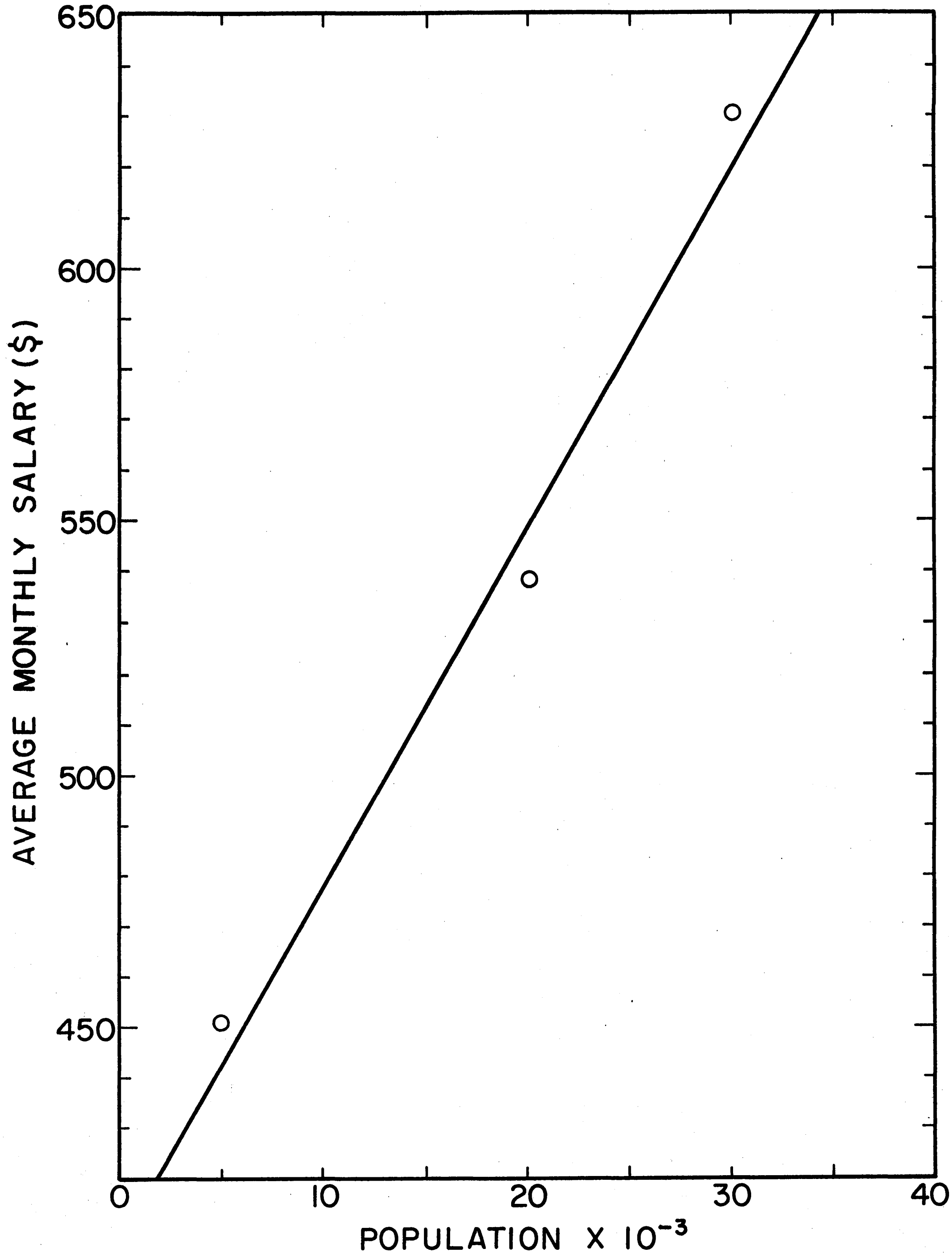


Figure 15. Average Monthly Salary for Parks and Streets Department Employees versus Population X $10^{-3}$

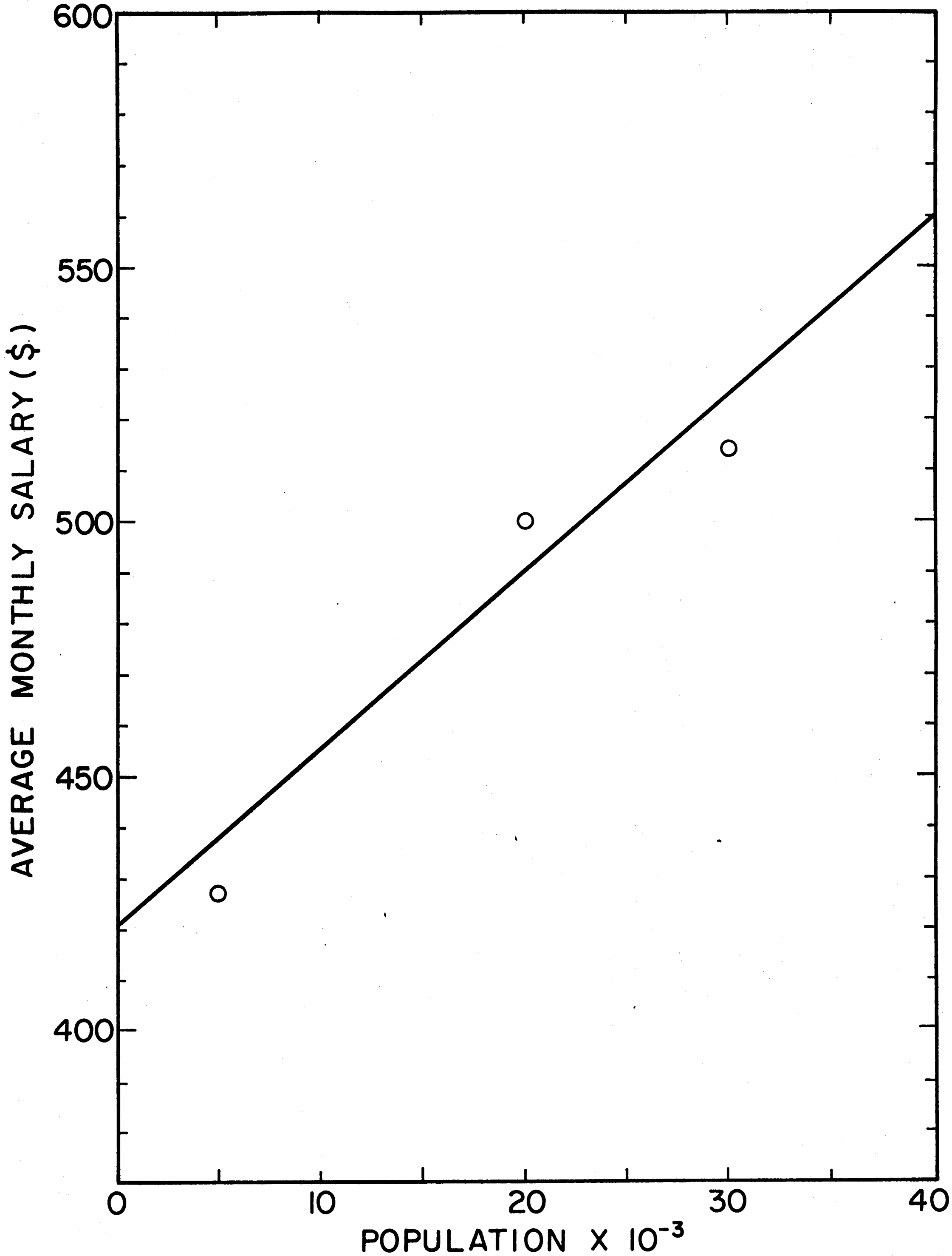


Figure 16. Average Monthly Salary for Garbage Department Employees versus Population X $10^{-3}$

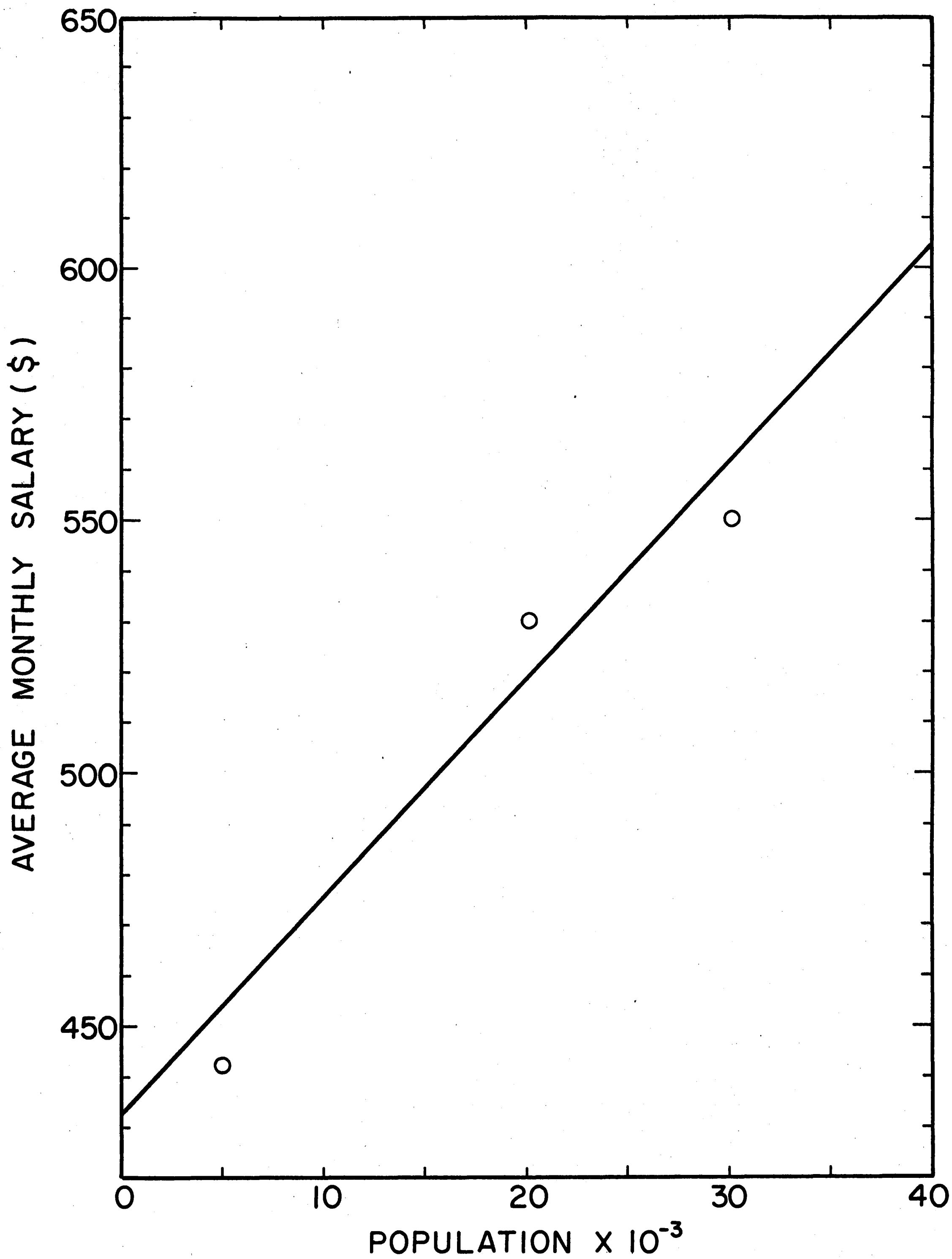


Figure 17. Average Monthly Salary for Utilities Department Employees versus Population X $10^{-3}$

# APPENDIX B

# PLAYER INSTRUCTIONS FOR PLEASANTVIEW, A MANAGEMENT GAME FOR CITY MANAGERS AND ADMINISTRATORS

## Introduction

Pleasantview is a computer-based management game for department heads and managers of small cities. The game allows the participant to experience the conflicting demands placed on a city manager as he attempts to allocate limited resources. These limited resources are used to meet the varied demands for public service by the citizen and the employee requirements for satisfactory levels of pay and workload. The time frame for one round of decisions is a simulated quarter of a year.

## Game Objectives

The game's primary objective is to allow the participant to experience the conflicting demands placed on a city manager as he attempts to allocate limited city resources to meet the demands for public service. Further, the game can provide city officials exposure to the effects their decisions can have on the system as a whole. These objectives stress an appreciation of the systems approach to city management.

## City System

Pleasantview can have a population ranging from 10 to 100,000 people. The size is at the discretion of the player. The simulated city environment has a total city budget derived from four revenue sources: sales tax, property tax, garbage fees, and utilities fees. The city budget provides the income for the five city departments: Police, Fire, Parks and Streets, Garbage, and Utilities departments. Each of these departments is described by six characteristics (or parameters):

1. Number of Employees
2. Total Budget
3. Non-salary Budget
4. Salary Budget
5. Level of Service
6. Employee Satisfaction.

The simulated city environment of Pleasantview is an abstract one and is not intended to represent any particular real city. The decision problems which the game poses to the player possess many of the same fundamental characteristics as those faced by real city managers.

## Decisions

The decisions and their description are listed below in the order of their occurrence in the game:

| Decision | Description |
|---|---|
| Population | Determines city size |
| Budget | Total city budget |
| Revenue Sources | Determine amounts of revenue from each source |
| 1. Sales tax | |
| 2. Garbage fees | |
| 3. Utility fees | |
| 4. Property tax | |
| Department | |
| Budget | Amount of total city budget that is allocated to the department |
| Number of employees | Number of employees needed in the department for acceptable service and workload |

| | |
|---|---|
| Salary Budget | Department budget used for salaries to maintain acceptable employee satisfaction |

The following relationships must be maintained by the player:

Total city budget = Sales tax + Garbage fees + Utility fees + Property tax

also

Total city budget = Police budget + Fire budget + Parks and Streets budget + Garbage budget + Utilities budget.

The total city budget must equal the sum of the revenue sources and the sum of the departmental budgets. If they are not equal, then the computer generates an error message and the player is required to make the correcting changes. The decision returns or score that each player gets is based upon theoretically correct decision values that are compared with the selected decision values.

## Decision Returns

Upon completion of the decision inputs, the game compares the player's decisions with the theoretically correct decision values. A set of indices is computed which is based upon these comparisons. Each department yields two indices: Level of Service (0-99) and Employee Satisfaction (0-99). The Level of Service index depends upon how the funds are distributed between the salary and non-salary budget and the employee morale. The Employee Satisfaction index is based upon employee morale. If this index falls too low, then the participant is faced with the possibility of a strike occurring in the department. The game yields one index for the total city which is a composite index based upon all the player's decisions. These indices are the participant's measure of performance. The higher they are, the better the decisions were. The game can be played using two different methods to input the participant decisions.

## Summary of Play

The game can be used with either an interactive typewriter terminal or with punched computer card input. The two types are described in the following sections.

### Interactive Typewriter Mode

In this mode, the participant interacts directly with the computer. First, a city population is chosen and the quarterly budget is input. At this point, the computer will request the sources of these funds. The participant must then enter what portion of the total budget will be obtained from each of the four revenue sources.

Having established a total budget and its sources, the participant now allocates these resources among the five city departments. The computer requests this allocation by department, and checks the total of these inputs against the selected total city budget.

After a review of the decisions made thus far, the next input requested is the number of men required for each department and the amount of departmental budget to be used for salaries.

Now, the computer evaluates the decision inputs for the three-month operation. The participant then receives his two departmental indices and the city index as shown below:

"For the Police Department

1. Level of Service (0-99) is 84

2. Employee Satisfaction (0-99) is 86

The city's total satisfaction (0-99) is 85.

Do you want to begin a new quarter?

Type one (1) if yes, and zero (0( if no."

Should the participant continue, he will repeat the decisions regarding revenue, budgets, and distribution. The game will automatically adjust the population upward to reflect city growth.

## Punched Card Mode

The punched card mode uses Fortran IV as the source language. In this mode, the participant makes all the decisions for a quarter and turns them in to the game administrator. The game administrator then inputs the decisions to the computer and returns the results to the participant.

# APPENDIX C

# PROGRAM LISTINGS

## Major Program Variables

1. pop - The population selected by the participant. Range is 10 to 100,000

2. budg - A quarterly budget selected by the participant

3. cmen (5) - The theoretically computed number of men needed for acceptable service in each of the five departments

4. cpay (5) - The theoretically computed values of the average monthly pay necessary for acceptable employee morale in each of the five departments

5. cbud (5) - The theoretically computed value of the total monthly departmental budget

6. coh (5) - The computed value of the quarterly departmental overhead

7. crev - The theoretically computed quarterly budget for a city with the given population

8. rev (4) - The selected revenue from each revenue source

9. bud (5) - The selected quarterly budget for each department

10. men (5) - The selected number of men needed for acceptable service in each of the five departments

11. sal (5) - The selected quarterly salary budget for each department

12. oh (5) - The selected quarterly non-salary or overhead budget for each department. (Internally computed as a function of the selected budget and the selected salary budget.)

13. pay (5) - The selected average monthly pay for each department. (Internally computed as a function of the selected salary budget and the selected number of men.)

14. empid (5) - The theoretically computed employee satisfaction index for each department

15. levser (5)- The theoretically computed level of service index for each department

16. citdx - The theoretically computed city satisfaction index

```
        /*  A MANAGEMENT GAME FOR CITY MANAGERS AND ADMINISTRATORS */;
        /*      */;
        /*  1. Description - Pleasantview is a hypothetical city that has five departments: */;
        /*   1. Police  */;
        /*   2. Fire  */;
        /*   3. Parks and Streets  */;
        /*   4. Garbage  */;
        /*   5. Utilities  */;
        /*      */;
        /*   The participant assumes the role of city manager and the game poses decisions which */;
        /*  have many of the same fundamental characteristics faced by real city managers. */;
        /*      */;
        /* 2. Objectives - The game has been developed to illustrate the basic problems in scarce */;
        /*   resource allocation for cities in the population range of 10 to 100000. */;
        /*      */;
        /* 3. Inputs - When the game is executed (xeq), the following inputs are requested from the */;
        /*  participant:    */;
        /*   1. Population (pop) - The desired city size. */;
        /*   2. Budget (budg) - The quarterly budget needed for this size city.*/;
        /*   3. Revenue sources - 1.Sales tax    (rev(1)) */;
        /*                        2.Garbage fees (rev(2)) */;
        /*                        3.Utilities    (rev(3)) */;
        /*                        4.Property tax (rev(4)) */;
        /*      */;
        /*   4. Departmental decisions:    (k=1 to5) */;
        /*    1. men(k) - Number of employees necessary for acceptable service. */;
        /*    2. bud(k) - Quarterly budget necessary for acceptable service.*/;
        /*    3. sal(k) - Quarterly salary budget necessary for dept.(k). */;
        /*      */;
        /* 4. Outputs - After the decision round is completed,the game issues two quarterly reports */;
        /*  for each department and one report for the total city which is a composite of all the */;
        /*  participant's decisions.    */;
        /*      */;
        /* 5. Simulation period - Three months. Should the participant decide to continue for more */;
        /*  quarters,the city's population is automatically increased. */;
        PUT LIST('          PLEASANTVIEW: A MANAGEMENT GAME FOR CITY ADMINISTRATORS');
        DECLARE rev(4) DEC(5),men(5) DEC(4),levser(5) DEC(4),ro(5) DEC(6), xx LABEL ;
        DECLARE sal(5) DEC(8),oh(5) DEC(8),pay(5) DEC(5);
        DECLARE empld(5) DEC(5),w(5) DEC(3),s(5) CHAR(20) VAR,r(4) CHAR(20) VAR;
        DECLARE cmen(5) DEC(6),cpay(5) DEC(6),chud(5),coh(5),bud(5);
        PUT LIST('Enter the city''s population(ex.30000).');
        xx=dc1;
        ON ERROR GO TO err1;
dc1:    GET LIST(pop);
        ON ERROR SYSTEM;
        GO TO dc2;
        PUT LIST('Enter a quarterly budget.(examp.,800000)');
        xx=dc2;
        ON ERROR GO TO err1;
dc2:    GET LIST(budg);
        ON ERROR SYSTEM;
        /*  kk is the automatic population increase for each succeeding quarter's round of decisions.  */;
        kk=0;
start:  pop=pop*(1+kk);
        p=pop/1000;
        kk=kk+.0123;
        cmen(1)=1.35965*p+3.5131;
        cmen(2)=1.3955*p+.2287;
        cmen(3)=.35104*p+1.754;
        cmen(4)=p+2.66665;
```

```
          cmen(5)=2.06287*p+1.98204;
          cpay(1)=10.89*p+450;
          cpay(2)=7.24*p+466.8;
          cpay(3)=7.14*p+406.8;
          cpay(4)=2.841*p+420;
          cpay(5)=4.32*p+432.8;
          /* The variable 'x' is the budget % alloted to salaries */;
          x=.5;
          sum=0;
reca:     DO k=1 TO 5;
          cbud(k)=cpay(k)*cmen(k)/x;
          coh(k)=(cbud(k)-cpay(k)*cmen(k))*3;
          sum=sum+cbud(k);
          END reca;
          /* Since cbud is a monthly figure,multiply sum by 3 to get the correct quarterly budget. */;
          /* Divide crev by 10000 to scale down for the decreasing returns function dexp.  */;
          crev=sum*3/10000;
          PUT LIST('   The city will receive its total budget from four different sources:');
          PUT LIST('              1. Sales tax');
          PUT LIST('              2. Garbage fees');
          PUT LIST('              3. Utilities');
          PUT LIST('              4. Property tax');
          PUT LIST('   Now you must decide how much of the total budget that each source will provide.');
a:        s(1)='Police';
          k1=Random(.5);
          s(2)='Fire';
          s(3)='Parks & Streets';
          s(4)='Garbage';
          s(5)='Utilities';
          r(1)='Sales  tax';
          r(2)='Garbage fees';
          r(3)='Utility fees';
          r(4)='Property tax';
          PUT LIST(' Enter the amount you expect to receive from each source.');
          xx=dc3;
          ON ERROR GO TO err1;
dc3:      GET LIST(rev(1),rev(2),rev(3),rev(4));
          ON ERROR SYSTEM;
          IF abs(budg-(rev(1)+rev(2)+rev(3)+rev(4)))>=1 THEN GO TO over1; ELSE GO TO ok1;
over1:    PUT IMAGE(rev(1)+rev(2)+rev(3)+rev(4),budg)(im1);
          GO TO dc3;
ok1:      PUT LIST(' Good. Now that you have decided where the money is coming from,the next step is to allocate the money');
          PUT LIST('');
          PUT LIST('   Pleasantview''s administration is divided into 5 departments which share the total budget:');
          PUT LIST('              1. Police services');
          PUT LIST('              2. Fire protection');
          PUT LIST('              3. Parks and Streets');
          PUT LIST('              4. Garbage collection');
          PUT LIST('              5. Utilities');
          PUT LIST('   You must now allocate funds to each department in the same manner as');
          PUT LIST('you did before for the revenue sources.');
          xx=dc4;
          ON ERROR GO TO err1;
dc4:      GET LIST(bud(1),bud(2),bud(3),bud(4),bud(5));
          ON ERROR SYSTEM;
          IF abs(budg-(bud(1)+bud(2)+bud(3)+bud(4)+bud(5)))>=.0001 THEN GO TO over2; ELSE GO TO ok2;
over2:    PUT IMAGE(bud(1)+bud(2)+bud(3)+bud(4)+bud(5),budg)(im1);
          GO TO dc4;
ok2:      PUT LIST(' Good. The next set of decisions that you will make involve each of the five depts. of the city');
          PUT LIST('You will next determine how many men that each department is to have, what the salary expenses');
```

```
            PUT LIST('will be and the amount of operating expenses. But first let''s review our current situation.');
            PUT LIST('');
            PUT EDIT('   Pleasantview has a population of ',pop,' .')(A,F(7));
            PUT EDIT('The quarterly budget of ',budg,' will be received from the following sources:')(A,F(7),A);
l:          DO k=1 TO 4;
            PUT IMAGE(r(k),rev(k))(im2);
            END l;
            PUT LIST('');
            PUT EDIT('  Total operating budget = $',budg,' per quarter.')(A,F(7),A);
            PUT LIST('');
            PUT LIST(' The amounts which you have allocated to each department are:');
            PUT LIST('');
            DO k=1 TO 5;
            PUT IMAGE(s(k),bud(k))(im3);
            END ;
            PUT LIST('');
            PUT LIST('    Now you will split up the operating budget for each dept. into 2 parts.');
            PUT LIST('The first part will be salaries and the second will be for other operating expenses');
            PUT LIST('or ''overhead''. Also now is the time to decide how many men each dept. will require.');
            PUT LIST('I suggest that you have a pencil ready to perform any minor calculations that will');
            PUT LIST('help you make your departmental decisions.');
l1:         DO k=1 TO 5;
            PUT LIST('');
            PUT LIST('   How many men will you need for the ',s(k),' dept.?');
            xx=dc5;
            ON ERROR GO TO err1;
dc5:        GET LIST(men(k));
            ON ERROR PUT IMAGE('')(im4);
            PUT LIST('');
            PUT EDIT('   Good. The ',s(k),' budget is ',bud(k),'. Enter the amount of the ',s(k))((3) A,F(8),(2) A);
            PUT LIST('budget which you desire to apportion to salaries.');
            xx=dc6;
            ON ERROR GO TO err1;
dc6:        GET LIST(sal(k));
            ON ERROR SYSTEM;
            oh(k)=bud(k)-sal(k);
            PUT EDIT('   Fine. Your decision leaves you with $',oh(k),' for operating expenses.')(A,F(7),A);
            pay(k)=sal(k)/(men(k)*3);
            /*    department calculations    */;
            mmen1=mmen(k);
            cpay1=cpay(k);
            coh1=coh(k);
            CALL exp(mmen1,mx,mc);
            CALL exp(cpay1,px,pc);
            r1=men(k)**mx/(mc+men(k)**mx);
            r2=pay(k)**px/(pc+pay(k)**px);
            t=Random;
            IF t>.75 THEN GO TO tag1;
            IF t>.5 THEN GO TO tag2;
            IF t>.25 THEN GO TO tag3;
            GO TO tag4;
tag1:       tag=1;
            GO TO emp;
tag2:       tag=.95;
            GO TO emp;
tag3:       tag=.8;
            GO TO emp;
tag4:       tag=.6;
emp:        empld(k)=tag*(.4*r1+.5*r2)*100;
            CALL exp(coh1,ox,oc
```

```
              ro(k)=oh(k)**ox*100/(oc+oh(k)**ox);
              levser(k)=.75*empld(k)+.25*ro(k);
              END l1;
              PUT LIST('');
              PUT LIST('    Pleasantview has just completed 3 mos. of operation based on your decisions.');
              PUT LIST('');
              PUT LIST(' You will now receive 2 reports from each dept. and 1 report for the total city');
              PUT LIST('which can be considered a composite report of the five depts. The higher the index');
              PUT LIST('the better the report.');
     l2:      DO k=1 TO 5;
              PUT LIST('    For the ',s(k),' dept.:');
              PUT EDIT('        1. Level of service(0-99) is ',levser(k))(A,F(6));
              PUT EDIT('        2. Employee satisfaction(0-99) is ',empld(k))(A,F(6));
              IF empld(k)<30 THEN CALL strik;
              PUT LIST('');
              END l2;
              /*   total city satisfaction    */;
              sum=0;
              w(1)=.2;
              w(2)=.2;
              w(3)=.25;
              w(4)=.25;
              w(5)=.1;
     l3:      DO k=1 TO 5;
              sum=sum+w(k)*levser(k);
              END l3;
              /* divide budg by 10000 to scale down for decreasing returns function. */;
              sbud=budg/10000;
              CALL dexp(crev,rx,rc);
              r1=rc*100/(rc+sbud**rx);
              citdx=.4*sum+.6*r1;
              PUT EDIT('    The city''s total satisfaction (0-99) is ',citdx,' This number is a measure of your')(A,F(6),A);
              PUT LIST('performance. The higher it is, the better your decisions are.');
              PUT LIST('Do you want to begin a new quarter? Type one(1) if yes or zero(0) if no.');
              xx=dc7;
              ON ERROR GO TO err1;
     dc7:     GET LIST(ans);
              ON ERROR SYSTEM;
              IF ans=0 THEN GO TO end;
              PUT LIST('  You will now begin a new quarter''s operation. Before you do,however,');
              PUT LIST('a thorough review of your decisions should be made.');
              GO TO dc2;
     end:     PUT LIST('END OF MANAGEMENT GAME');
              GO TO fin;
     im1:     IMAGE;
Trouble here. I got -------- which is not = -------- Try  again.
     im2:     IMAGE;
------------ collections = $-------.
     im3:     IMAGE;
--------------- services = $--------.
              /*    Decreasing  Returns  Function          */;
     dexp:    PROCEDURE (df,dx,dc50);
              c1=1.7;
              c3=1.3;
              d2=c1*df;
              c2=.01;
              d3=c3*df;
              c4=.9;
              c=c2*d2/(1-c2);
              dx=(LOG(d2)-LOG(c)-LOG(1-c4)+LOG(c4))/(LOG(d2)-LOG(d3));
              ON ERROR dc50=.71E75;
              dc50=c*d2**(dx-1);
```

```
          ON ERROR SYSTEM;
          END lexp;
err1:     PUT LIST('Trouble here. You must not have typed a number. Try again.');
          GO TO xx;
          /*     Increasing  Returns  Function         */;
exp:      PROCEDURE (f,x,c50);
          c1=.1;
          c3=.9;
          d2=f*c1;
          c2=.01;
          d3=f*c3;
          c4=.9;
          c=d2*(1-c2)/c2;
          x=(LOG(d2)-LOG(c)+LOG(1-c4)-LOG(c4))/(LOG(d2)-LOG(d3));
          c50=c*d2**(x-1);
          END exp;
strik:    PROCEDURE ;
          kk=rAndom;
          IF kk<=.5 THEN GO TO tal;
          GO TO enstrl;
          PUT LIST(' A strike has occured in the ',s(k),' dept. Probable cause is overworked or');
tal:      PUT LIST('underpaid employees. Try to improve the situation next quarter.');
enstrl:   END strik;
fin:      ;
```

```
0000000000111111111122222222223333333333444444444455555555556666666666777777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD
       DIMENSION REV(4),BUD(5),SAL(5),OH(5),PAY(5),C1(5),C2(5),
      AC3(5),C4(5),C5(5),EIDX(5),W(5),S(5),R(4),CMEN(5),CPAY(5),
      BCBUD(5),CCH(5),RC(5),XHED(5,8),MEN(5),LEVSER(5)
       REAL MX,MC,MEN
       INTEGER EMPIC(5),CITCX
       DATA CBUD,CCH,RC/5*0.,5*0.,5*0./
       DATA XHED/'FOR ','FOR ','FOR ','FOR ','FOR ','THE ','THE ','THE ',
      A'THE ','THE ','POLI','FIRE','PARK','GARB','UTIL','CE D',' DEP','S
      BAN','AGE ','ITIE','EPT.','T.: ','D ST','DEPT','S DE',':   ','    '
      C,'REET','.:  ','PT.:','    ','    ','S DE','    ','    ','    ',
      D    ','PT.:','    ','    '/
       NR = 124645313
       NI = 5
       NO = 6
       WRITE(NC,3000)
       WRITE(NO,1000)
       READ(NI,1100)POP,BUDG,(REV(J),J =1,4)
       READ(NI,1100)(BUD(K),K=1,5)
       READ(NI,1100)(MEN(K),K=1,5)
       READ(NI,1100)(SAL(K),K=1,5)
       P = POP/1000
       CMEN(1) = 1.36*P + 6.5
       CMEN(2) = 1.40*P + 0.23
       CMEN(3) = 0.35*P + 1.75
       CMEN(4) = 0.0 *P + 2.67
       CMEN(5) = 2.06*P + 1.98
       CPAY(1) = 10.89*P + 450
       CPAY(2) =  7.24*P + 466.8
       CPAY(3) =  7.14*P + 406.8
       CPAY(4) =  2.84*P + 420
       CPAY(5) = 4.32*P + 432.8
C
C     'X'IS THE BUDGET % ALLOTED TO SALARIES
C
       X=.5
       SUM = 0
       DO 100 K=1,5
       CBUD(K) = CPAY(K) * CMEN(K)/X
       CCH(K) =  (CBUD(K)-CPAY(K)*CMEN(5))*3
       SUM = SUM + CBUD(K)
  100 CONTINUE
C
C   COMPUTE THE CORRECT REVENUE AND EXPENDITURES. (SUM IS A MONTHLY FIGURE.)
C 10,000 IS A SCALE FACTOR FOR SUBROUTINE DRETFN.
C
       CREV = SUM*3/10000
       DO 200 K=1,5
       OH(K) = BUD(K) - SAL(K)
       PAY(K) = SAL(K)/MEN(K)
C
C  DEPARTMENT CALCULATIONS
C
       CMEN1 = CMEN(K)
       CPAY1 = CPAY(K)
```

```
000000000111111111122222222223333333333444444444455555555556666666666777777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
      COH1 = COH(K)
      CALL IRETFN(CMEN1,MX,MC)
      CALL IRETFN(CPAY1,PX,PC)
      R1 = MEN(K)**MX/(MC+MEN(K)**MX)
      R2 = PAY(K)**PX/(PC+PAY(K)**PX)
      T= RANF(0)
      IF(T.GT..75)GO TO 110
      IF(T.GT..50)GO TO 120
      IF(T.GT..25)GO TO 130
      GO TO 140
  110 TAG = 1
      GO TO 150
  120 TAG = .95
      GO TO 150
  130 TAG = .8
      GO TO 150
  140 TAG = .6
C
C  EMPLOYEE SATISFACTION IS A FUNCTION OF NO. OF MEN AND PAY.
C
  150 EMPID(K) = TAG*(.4*R1 + .6*R2)*100
C
C  LEVEL OF SERVICE CALCULATIONS.
C
      CALL IRETFN(COH1,OX,OC)
      RO(K) = OH(K)**OX*100/(OC + OH(K)**OX)
      LEVSER(K) = (.75*EMPID(K) + .25*RO(K))
  200 CONTINUE
      DO 300 K=1,5
      WRITE(NO,2000)(XHED(K,L),L=1,8)
      WRITE(NO,1400)LEVSER(K),EMPID(K)
      IF(EMPID(K) - 30)210,210,300
  210 CALL STRIKE(NP,NO)
  300 CONTINUE
C
C   THE FOLLOWING SEGMENT COMPUTES THE CITY'S TOTAL SATISFACTION INDEX.
C THE WEIGHTS, W(K),GIVE DIFFERENT EMPHASIS TO THE DEPARTMENTS' LEVEL OF
C SERVICE. R1 IS THE RETURN FOR THE BUDGET DECISION.
C
      W(1) = .20
      W(2) = .20
      W(3) = .25
      W(4) = .25
      W(5) = .10
      SUM = 0
      DO 400 K=1,5
      SUM = SUM + W(K)*LEVSER(K)
  400 CONTINUE
C
C   SCALE DOWN BUDG.
C
      SBUD = BUDG/10000
      CALL DRETFN(CREV,RX,RC)
      R1 = RC*100/(RC + SBUD**RX)
```

```
000000000111111111122222222223333333333444444444455555555556666666666777777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
      CITDX = .4*SUM + .6*R1
      WRITE(NO,1500)CITDX
 1000 FORMAT(9X'PLEASANTVIEW - A MANAGEMENT GAME FOR CITY ADMINISTRATORS
     A')
 1100 FORMAT(7F10.)
 1400 FORMAT(1H0,'1. LEVEL OF SERVICE(0-99) IS',I3/1H ,'2. EMPLOYEE SATI
     ASFACTION(0-99) IS',I3)
 1500 FORMAT(1H0,'THE CITY''S TOTAL SATISFACTION IS:',I3)
 2000 FORMAT(1H0,8A4)
 3000 FORMAT(1H1)
      STOP
      END
C
C     INCREASING RETURNS FUNCTION
C
       SUBROUTINE IRETFN(F,X,C50)
      C1 = .1
      C3 = .9
      D2 = C1*F
      C2 = .01
      D3 = C3*F
      C4 = .9
      C = D2*(1-C2)/C2
      X = (ALOG(D2)-ALOG(C)+ALOG(1-C4)-ALOG(C4))/(ALOG(D2)-ALOG(D3))
      IF(X.GT.174)X=174.
      C50 = C*D2**(X-1)
      RETURN
      END
C
C     DECREASING RETURNS FUNCTION. DF IS THEORETICALLY CORRECT DECISION.
C  IF THE DECISION IS GREATER THAN DF, THE RETURN WILL BE LOWER.
C
      SUBROUTINE DRETFN (DF,DX,DC50)
      C1 = 1.7
      C3 = 1.3
      D2 = C1*DF
      C2 = .01
      D3 = C3*DF
      C4 = .9
      C = C2*D2/(1-C2)
      DX= (ALOG(D2)-ALOG(C)-ALOG(1-C4)+ALOG(C4))/(ALOG(D2)-ALOG(D3))
      DC50 = C*D2**(DX-1)
      RETURN
      END
C
C          STRIKE SUBROUTINE
C
      SUBROUTINE STRIKE(NR,NC)
      SK = RANF(0)
      IF(SK - .5)10,10,20
   10 WRITE(NO,2200)
   20 RETURN
 2200 FORMAT(1HC,'A STRIKE HAS OCCURED IN THIS DEPARTMENT. PROBABLE CAUS
     AE IS UNDERPAID OR OVERWORKED EMPLOYEES. '/'TRY TO IMPROVE THE SITU
```

```
      00000000011111111112222222222333333333344444444445555555555666666666677777777778
      12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD
 163        BATICN NEXT CLARTEF.')
 164         END
```

# VITA

Charles Moody Parks

Candidate for the Degree of

Doctor of Philosophy

Thesis: A MANAGEMENT GAME FOR CITY MANAGERS AND ADMINISTRATORS

Major Field: Industrial Engineering and Management

Biographical:

Personal Data: Born in Ponca City, Oklahoma, September 26, 1943, the son of Mr. and Mrs. Moody R. Parks.

Education: Graduated from Ponca City Senior High School, Ponca City, Oklahoma, in May, 1961; received Bachelor of Science degree in Industrial Engineering and Management in 1972 and the Master of Science degree in Industrial Engineering and Management from Oklahoma State University in 1973; completed requirements for the Doctor of Philosophy degree at Oklahoma State University in December, 1975.

Professional Experience: Electronics Technician, Oklahoma State University Research Foundation, 1969-1972; Graduate Teaching Assistant, 1972-1973; Instructor, 1974, School of Industrial Engineering and Management, Oklahoma State University; currently Assistant Professor, Department of Industrial Engineering, Mississippi State University.