# URBAN PLANNING ANALYSIS: METHODS AND MODELS

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# *Urban Planning Analysis:*
# *Methods and Models*

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# *Preface*

This book is an introduction to the basic quantitative techniques of urban planning and policy analysis. The development and diffusion of these techniques within professional practice have been limited by historical factors. Modern city and regional planning originated in a loose collaboration among a diverse group of urban reformers during the late nineteenth and early twentieth centuries. It included housing economists, public health officials, zoning lawyers, local government reformers, civil engineers, urban sociologists, geographers, architects, and landscape architects. But as universities began to train professionals for this movement, their programs of study did not fully succeed in spanning this multidisciplinary foundation. Professional training became mainly the province of the design professions of architecture and landscape architecture, neither of which had the strong bookish habit of theory building, characteristic of most of the sciences. Thus, while urban theory and analytic methods were generated primarily by economists, sociologists, and geographers, the tools that they developed were added very slowly to the mainstream of city planning. The profession's centers of training did not become the national centers of urban theory and scientific research. The gap that developed between practice and theory, between urban action and urban analysis, became so broad that a pressure of almost revolutionary proportion was necessary to close it. This revolution came in the late 1950s and throughout the 1960s. The increased pace of quantification in the social sciences, together with a shift in governmental and academic priorities toward a more intense concern for urban problems, precipitated radical changes both in planning practice and the education of practitioners.

In the field of practice we have witnessed a tendency for analytic techniques to exhibit a leapfrogging behavior, jumping from the stages of initial invention, over the heads of the main body of the profession, directly to very high levels of abstraction. The effect has been a kind of capitalistic monopoly of technical knowledge, maintained in the language of higher mathematics by persons who know how to use it. Partly as a result of this process, many very expensive mistakes have been made in the name of the planning profession by selling to the public, at an enormous cost, models of analysis that have been mainly untested and that have proved to be highly impractical.

In academic settings, where these sophisticated techniques have been introduced into the intellectual traditions of planning, the language and culture of professional training has tended to replace one very esoteric language—the traditional language of architectural taste and design—with another, the new language of mathematics and statistics. Intellectual leadership within the field, to use a social analogy, has simply been transferred from one elite to another.

Neither the traditions of social science nor the traditions of planning practice have been very successful in dealing with the problems of urban policy development. Therefore, we believe that leaping back and forth from one to the other is not a solution. One of our basic objectives is to help establish a middle ground, the common foundation on which planners and social scientists, in concert, can build more suitable and stable extensions of urban analysis to enhance the efficiency of public policymaking.

Students and professionals who have come to the study of urban systems with no familiarity with and/or facility for quantitative procedures have found almost no opportunity, in this highly interdisciplinary field, for sympathetic instruction at an elementary level. This has been true for both those in the academically oriented social sciences in search of fields of application, and for those in the field of planning in search of analytic discipline. For students with a natural skill in mathematics, this has not necessarily been a problem. They have been able, in many cases, to refer to textbooks of sociology, business administration, economics, and engineering and, with considerable effort, have been able to make the transition from those contexts into the area of urban applications. Our efforts here are directed toward students who find such a procedure inefficient and to those who pursue mathematics and statistics with uneasy hesitation or even a sense of fear. We have found that most people attempt to understand quantitative analysis, not because they are attracted by the elegance of mathematics and logical reasoning, but because they want to understand a specific practical problem concerning, for example, housing, education, transportation, or health. Quantitative analysis in this practical context is a means to an end, not an end in itself—and a bothersome one in many instances. The basic methods and models of planning are fundamentally quite simple. Yet, ignorance of these techniques not only can be an obstacle but also can leave one vulnerable to exploitation. People and communities can be exploited by their public servants, public planners can be exploited by private interests and expert consultants, and research centers and university professors can exploit almost everybody, including each other. Everyone is vulnerable. The lessons of the past tell us all too clearly that well-intentioned humanists will continue to lose the battles for people, cities, and the environment until they come to terms with these instruments and their role in these struggles. We believe that all planners should acquire a knowledge of these tools, should know their strengths and weaknesses, and should then use them judiciously to get on with the work.

For these reasons we always attempt here to begin our presentations and discussions from the position of realistic problems and decisions and, then, to show how particular techniques can be brought to the analysis of those problems and can contribute to their solution. Some topics are not included here that some readers may feel should have been included. Mathematicians and statisticians may wonder why we do not introduce set theory as a foundation for probability theory, or why calculus is not used to describe probability distributions or to find the least-squares solution in regression analysis. Our intention has been to include only the concepts and computations that have a genuine and direct application to problems in urban planning analysis—not those that we and other theoreticians may feel should be applied, but those that, indeed, are in daily application.

In attempting to avoid the difficulties and pitfalls of speaking strictly from within the disciplinary framework of mathematics and statistics, we may leave an impression that the methods and models we present are not of a general nature and, therefore, are not applicable to a broad spectrum of problems beyond the particular problem on which we have chosen to demonstrate each technique. All of the analytic procedures discussed here are, in fact, quite general in nature and can be applied to a wide range of decision problems. We risk being misinterpreted on this point because we are too familiar with the alternative gamble in which students are presented with general theories and abstract methods that usually cannot be translated into the students' own practical context. The difficulty with general mathematical and statistical theory, at this stage of learning, is that it requires, in order to present a coherent chain of logical reasoning and proof, the introduction and exercise of numerous concepts and operations that simply do not translate directly into real problem solving. Thus the cautious and, perhaps, fearful reader of such a treatment finds it too easy to indict the whole system of quantitative analysis as being irrelevant and ungrounded in his practical experience. Of course, such a conclusion is largely correct. That is why we have tried to derive the structure and development of our presentation from the structure of urban problems and from the development of planning and decision processes, rather than relying exclusively on the traditional modes of mathematical presentation.

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# *Use of the Book*

This book is divided into two parts. Part I is comprised of seven chapters and is a sequential treatment of the various stages of a rational planning process. It begins with the definition of the planning process, the role of standards and goals, and the structuring of problems, and progresses through information gathering, the specification of alternative solutions and outcomes, the estimation of the impacts of solutions on goals, program evaluation and selection and, finally, the management of program implementation. The principal analytic tools introduced throughout this sequence include the calculation of need gaps, causal diagrams, sampling and survey research methods, data tabulation, descriptive statistics, hypothesis testing, correlation and regression analysis, cost-effectiveness and cost-benefit analysis, program evaluation and review technique, and critical path analysis.

Part II presents models of urban systems that are widely used in planning analysis. Simple and complex models of population projection, models of location and travel behavior, and the simulation of large-scale transportation systems are discussed in Chapters 8 to 10. Chapter 11 is a slight exception in format. At this point, if not sooner, most readers can easily understand the need for a more manageable algebra for handling the data and computations of these complex models. Linear algebra, or matrix algebra, is introduced to fill this need. The final chapter presents models of regional income and employment analysis.

This work is intended for three groups: (1) upper-level undergraduate students in urban studies or the social sciences who have had some preparation in the nature of urban systems and social policy questions; (2) graduate students either directly in the field of urban and regional planning or in related professions who may wish to explore the field of urban policy analysis; and (3) practicing planners who either have had no adequate opportunity to study these methods and models or who feel the need for renewing or restructuring their knowledge in this area. We assume, by way of mathematical preparation, only training in high school algebra or a first-year college course in algebra for nonmathematicians and nonscience students. In fact, we even assume that most of that study will have been forgotten. In the process of writing this book, with the help of some of our colleagues, we used all of the book's material in both undergraduate and graduate classrooms and found this to be of invaluable assistance, leading to beneficial rewritings, reorganizations, and some corrections. As a textbook, we suggest that the book be used for a full academic year course or sequence of courses. This can be done for either undergraduate or graduate classes, depending on their abilities.

More difficult sections often can be passed over without losing continuity, such as the section on the binomial distribution in Chapter 3 and some of the later sections of Chapters 6, 11, and 12. Where students are able to proceed through the material at a fairly rapid pace, as we find to be true of some undergraduates as well as graduates, it is beneficial to supplement the chapters with the suggested additional readings in both computational theory and practical application. We also find it easy and useful to introduce computer usage at several stages in the learning process. For example, we define research projects that require the selection of a sample, keypunching, and simple data description with the use of packaged computer programs and find this to be a stimulating aid in the study of Chapters 2 and 3. Also, we ask students to take the same sample of data and to analyze it further through the use of packaged statistical programs for regression and correlation analysis on the computer in conjunction with Chapters 4 and 5. This can be easily accomplished with programs from the Biomedical Computer Programs or the Statistical Package for the Social Sciences. The importance, in a subject like this, of learning by doing and of comparing hand calculations with machine calculations can hardly be overemphasized.

Our concerns for planning practice again have caused us to emphasize not only the theory of various models but also to spend a considerable amount of time demonstrating the procedures for estimating and fitting these models—procedures often neglected or obscured in the available literature. Sets of problems and selected bibliographies accompany each chapter. We have tried to keep down the items in each bibliography to a reasonable number, considering balance with respect to theory and practice, elementary versus advanced treatments, and complementary versus supplementary materials. Of course, there are many excellent items in the literature that have not been cited and that could easily be substituted for the ones we included.

Because of space limitations, we have not introduced some of the newer techniques, such as linear programming (although we do sneak in a little here and there), models of natural resource systems, social area analysis, social indicators, management information systems, models of the design process, and the like. This has been done not because we are unaware or unsympathetic to any of these areas of analysis, but because we believe that a comprehensive survey format would force other compromises in depth of treatment and would simply create an information overload for those to whom the book is primarily addressed.

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D. A. K.
A. L. S.

# Contents

## PART II MODELS

### 8 PROJECTING POPULATION



### 9 LOCATION AND TRAVEL BEHAVIOR