contributions to economic analysis

Peter NIJKAMP
Piet RIETVELD/Editors

Information Systems for Integrated Regional Planning

North-Holland

INFORMATION SYSTEMS FOR INTEGRATED REGIONAL PLANNING

CONTRIBUTIONS
TO
ECONOMIC ANALYSIS

149

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INFORMATION SYSTEMS FOR INTEGRATED REGIONAL PLANNING

Edited by

PETER NIJKAMP

and

PIET RIETVELD

Department of Economics
Free University
Amsterdam, The Netherlands

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INTRODUCTION TO THE SERIES

This series consists of a number of hitherto unpublished studies, which are introduced by the editors in the belief that they represent fresh contributions to economic science.

The term "economic analysis" as used in the title of the series has been adopted because it covers the activities of both the theoretical economist and the research worker.

Although the analytical methods used by the various contributors are not the same, they are nevertheless conditioned by the common origin of their studies, namely theoretical problems encountered in practical research. Since, for this reason, business cycle research and national accounting, research work on behalf of economic policy, and problems of planning are the main sources of the subjects dealt with, they necessarily determine the manner of approach adopted by the authors. Their methods tend to be "practical" in the sense of not being too far remote from application to actual economic conditions. In addition they are quantitative rather than qualitative.

It is the hope of the editors that the publication of these studies will help to stimulate the exchange of scientific information and to reinforce international cooperation in the field of economics.

The Editors

PREFACE

We should all be concerned about the future because we will have to spend the rest of our lives there.

Charles F. Kettering
Seed for Thought (1949)

The period after the Second World War has been marked by a wave of information that has flooded many societies, east and west. Information systems have become indispensable for planning and decision making in both private and public agencies. Recent advances in microelectronics, in particular, have offered enormous potential for using information in a logical and well structured way for handling complex problems of choice and decision.

Usually, however, information systems in public policy making are oriented toward either the national level or the detailed local level. So far, the *regional* dimensions of socioeconomic development have not been adequately represented in information systems for regional planning.

This book is the result of an endeavor to fill the gap by addressing key issues of information systems for planning regional development, by evaluating trends in the progress of information systems, by identifying the greatest difficulties in their use for aiding long-term regional development, and by focusing attention on the possibilities of new operational tools in modern information systems.

The study, based on a joint effort of several experts on information systems for regional planning, was initiated by the Integrated Regional and Urban Development Group at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria and the Department of Regional Economics at the Free University in Amsterdam. This cooperation led to a network of scholars who were interested in contributing to a comprehensive survey of the subject. Several results of the project were also discussed at a workshop held at IIASA in December 1982.

The aim of the book is to show that planning-oriented information systems are powerful tools in regional decision making and policy making. Some of the issues discussed are mentioned here:

- Is there a unifying methodology for integrated information systems that will adequately represent regional systems as a whole, as well as specific parts and aspects of a regional system?
- How can one secure the complete and coherent representation of a regional economy, so that it may be regarded in planning as a socioeconomic system interacting with the national (or international) economy and with other regions?

- How can intraregional socioeconomic, demographic, and political mechanisms be included in information systems so as to identify the key forces of change in the structure of a regional economy?
- What should be done in the design and use of information systems to enhance the understanding and cooperation between the "actors" in regional planning and regional development analysis: the planners, model builders, systems analysts, statisticians, and data-processing specialists?
- Which new developments in information technology promise to improve regional information for planning and decision making?

Altogether, this study has a strong methodological and practical bias. Technical aspects will be touched upon only insofar as they are consistent with this approach.

Finally, we wish to express our gratitude to Dr. Manfred M. Fischer of the Department of Geography, University of Vienna for his outstanding help in making constructive comments on the first draft of the book; to Dr. Geoffrey J.D. Hewings for his suggestions on parts of the final chapter; and to Professor Börje Johansson, Acting Leader of the Integrated Regional and Urban Development Group at IIASA, for his continuous support, especially after the death of the former Leader, Professor Boris Issaev.

Peter Nijkamp
Piet Rietveld

Amsterdam, May 1983

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THE INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS

is a nongovernmental research institution, bringing together scientists from around the world to work on problems of common concern. Situated in Laxenburg, Austria, IIASA was founded in October 1972 by the academies of science and equivalent organizations of twelve countries. Its founders gave IIASA a unique position outside national, disciplinary, and institutional boundaries so that it might take the broadest possible view in pursuing its objectives:

To promote international cooperation in solving problems arising from social, economic, technological, and environmental change

To create a network of institutions in the national member organization countries and elsewhere for joint scientific research

To develop and formalize systems analysis and the sciences contributing to it, and promote the use of analytical techniques needed to evaluate and address complex problems

To inform policy makers and decision makers of how to apply the Institute's methods to such problems

The Institute now has national member organizations in the following countries:

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The Austrian Academy of Sciences

Bulgaria
The National Committee for Applied Systems Analysis and Management

Canada
The Canadian Committee for IIASA

Czechoslovakia
The Committee for IIASA of the Czechoslovak Socialist Republic

Finland
The Finnish Committee for IIASA

France
The French Association for the Development of Systems Analysis

German Democratic Republic
The Academy of Sciences of the German Democratic Republic

Federal Republic of Germany
The Max Planck Society for the Advancement of Sciences

Hungary
The Hungarian Committee for Applied Systems Analysis

Italy
The National Research Council

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Union of Soviet Socialist Republics
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United States of America
The American Academy of Arts and Sciences

PART A

Information Systems for Regional Planning: Rationale and Methodology

Information Systems for Integrated Regional Planning
P. Nijkamp and P. Rietveld (editors)
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CHAPTER 1

Information Systems: A General Introduction

Peter Nijkamp

1. Introduction

Since the Second World War almost all countries of the world have experienced an information explosion. The introduction of computers, microelectronic equipment, and telecommunications services has paved the way for an avalanche of information, not only for scientific research but also for use by a broader public and by planners and policy makers (Burch *et al.* 1979, Debons and Larson 1983).

There are several reasons that may explain the information explosion in planning and policy making. First of all, the complexity of modern society has led to a general need for adequate insight into the mechanisms and structures determining intertwined societal processes.

Secondly, to avoid the enormous risks and costs incurred by taking wrong decisions today requires careful judgment, based on sufficient information about the consequences of all alternative courses of action.

In the third place, public policy institutions themselves adopt complicated positions arising from conflicting interests. In negotiations between such agencies information can be used as a powerful tool.

Next, in recent decades many statistical offices (national, regional, and urban) have produced a great deal of data that are available for further treatment or analysis.

Another factor that has stimulated the present information wave is the progress in statistical techniques and in econometric modeling, which has permitted data of different kinds to be manipulated to suit the needs of planners, decision makers, or politicians.

Finally, modern computer hardware and software (decision support systems, for instance) have made possible the quick and flexible treatment of a wide variety of data relevant to policy analysis. The data storage capacity that is available today favors a much better organized use of information than was possible previously.

All these factors have led to the widespread use of appropriate and manageable information for decision making, not only by the individual but also at the level of social and economic organizations (Sowell 1980). In the developed world and in developing countries, proper and systematic information is regarded as a prerequisite for successful planning (Casley and Lury 1981).

It should be emphasized here that, in principle, there is a substantial difference between *data* and *information* (Burch *et al.* 1979). Data are numerical representations, or other symbolic surrogates, that characterize people, organizations, objects, events, or concepts. Information means data that are structured (by way of modeling, organizing, or converting data) so as to improve insight or knowledge regarding a certain phenomenon. Thus an information system is based on a systematic data transformation that aims at providing analytic support to planners and decision makers (Rittel 1982). An information system should be judged by its contribution to solving, organizing, or rationalizing complex choice and decision problems.

The purpose of this book is to present a scientific reflection on information systems for planning and policy analysis. Because of the information explosion, there is a need for a closer investigation of information systems for public policy making. The following arguments may justify this endeavor.

Firstly, information systems (especially those having many kinds of information) may provide an integrative framework for multidisciplinary work, since they include the features necessary for communication between such disciplines as geography, planning, economics, ecology, demography, regional science, and public management.

Next, data and information systems contribute to the foundation of operational analysis. Without this empirical and testable foundation, we may run into misinterpretations of complex mechanisms, especially if the long-term dynamics of social or spatial systems are to be taken into account.

Thirdly, data and information systems determine the actual relevance of scientific analysis for society, for planning, for management, and for policy making. They act as a filter for identifying and specifying empirically a precisely demarcated policy or choice problem.

Furthermore, data and information systems are also a prerequisite for building, testing, and using models. Data are necessary for judging the validity of a model and provide an empirical test of model behavior. A model does not have absolute validity, for its purpose is to describe a subsystem of a complex reality. Consequently, a "good" model derives its value from its empirical basis; it cannot be used to test the reliability of data. In a provocative article published recently, Leontief (1982), the Nobel Laureate in economics, discussed the friction between theory and application in social sciences. He found that, at least in economics, only a small proportion of scientific analysis was rooted in reality and empirical observations. The majority was just theory. He strongly criticized this "theorizing on non-observed facts." In his view, many scientists are making assumptions instead of collecting data and using them. He showed convincingly that a substantial operational foundation based on facts is necessary for mature scientific analysis.

Finally, public policy making is increasingly evolving into conflict management, in which each interest group or decision agency uses its own arguments based on a specific information system. A careful analysis of information systems may provide a rational framework for judging different, sometimes conflicting options.

Clearly, there are many trade-offs involved in collecting data and developing information systems: accuracy, adaptability, and availability have to be weighed against the consequences in terms of financial benefits and costs. In this regard, special attention has to be given to the benefits and costs of user–surveyor interactions. A necessary condition for manageable exchange of information is a permanent user–surveyor dialogue that will guarantee meaningful coordination of the various tasks in a planning process.

Because of the wide variety of urgent problems in the world (from global to local), there is a need for a coherent framework for information systems, as almost all technological, socioeconomic, spatial, and environmental processes develop together. The provision of reliable, manageable, and up-to-date information, structured according to a sound methodology, is essential in order to understand and to influence such processes in a rational and systematic way. Coherent information systems for regional planning should contain the necessary data on the elements of a socioeconomic system, on their properties, their linkages, and their dynamics. But, as will be indicated later, the *spatial* dimensions of socioeconomic development have not yet been considered adequately in information systems for public planning and decision making.

In general, information is the integrative basis to all planning and decision activities. The inadequacy of information often renders economic models ineffective or inoperable, leads to a misunderstanding of the real mechanisms of socioeconomic systems and to inconsistent decisions, and hampers communication between planners and model builders. It is, therefore, important to determine whether current trends in planning-oriented information systems are promising and, if they are not, to indicate the steps to be taken to adapt them better to the needs of planners. It may be particularly useful to identify bottlenecks and failures in the use of information systems, so that new strategies for designing and applying coherent information systems can be developed. In this process the attention of persons and institutions responsible for the design of decision support systems for planning may be directed also to various qualitative issues crucial to development planning. Such issues can often be included in modern information systems, because entirely new possibilities for data storage and data treatment have arisen. Therefore, information systems may act as a vehicle for identifying systematic patterns in a complex, dynamic world.

Our era is indeed the era of information. But, at the same time, the identification of meaningful structures and patterns in the mass of information that confronts us is fraught with many problems. The need for better information for planning has evolved into the need for better planning of information.

2. Information as a Process

As stated in the introduction, information is more than a set of data, as its aim is to provide analytic support to a decision maker. An information process takes place when the insight of the decision maker into a choice problem is improved by access to logically organized data. This process can have two effects, namely an increase in knowledge about a phenomenon, or a decrease ("misinformation"). The latter aspect is extremely relevant, as very often scientific analyses may lead to a removal of certainty that a decision maker had regarding the expected outcomes of his decisions. Thus, a rise or a decline in the degree of certainty about the occurrence of a particular phenomenon may be called "information" (Rittel 1982). Information in a planning framework may have an impact (positive or negative) on various types of knowledge (Rittel 1982): conceptual (theoretical), factual (descriptive), deontic (normative), explanatory (causal), and instrumental (goal-oriented).

A specific kind of uncertainty emerges if different information systems (e.g. models) lead to different outcomes. In that case, a decision maker might use the contradictory results of two information systems to create more public uncertainty (i.e. confusion) so as to achieve an expansion of his own decision space. This so-called *strategic* uncertainty may emerge especially if the foundations, definitions, data, and purposes of the information systems are not clearly specified.

Information can thus also be linked with *surprise*. A message contains more information as the discrepancy between prior (expected) results and posterior (realized) results increases. Theil (1967) used the latter viewpoint to develop his conception of information theory, in which Shannon and Weaver's classic measure of information is one of the elements used for judging the relevance of information for decision making. The input of organized data (information) brings more order to an otherwise less organized complex system (Scheele 1983). Raising the information content (or *negentropy*) removes uncertainty and reduces the entropy of a system. This information process will depend on the capability of the system to incorporate the extra information (Webber 1982).

As mentioned before, a restructuring and interpretation of data is a prerequisite for generating information. This treatment may be for various purposes (Burch *et al.* 1979). Examples are:

capturing	recording data systematically
verifying	confirming the validity of data
classifying	sorting data into specific classes
arranging	placing data in a predetermined sequence
summarizing	aggregating data into new sets
calculating	manipulating data arithmetically
forecasting	extrapolating data into the future
simulating	assessing and manipulating lacking data
storing	placing data on to storage media
retrieving	selecting data from storage media
communicating	transferring data to other users.

All these operations are determined by the contribution of the information system at hand to solving planning and policy problems. The choice of operations very much depends on the related costs arising *inter alia* from personnel requirements, the modularity, flexibility, and versatility of the information system, and the processing speed and control. The benefits of an information system depend *inter alia* on its accessibility, comprehensiveness, accuracy, appropriateness, timeliness, flexibility, verifiability, freedom from bias, and quantifiability.

Clearly, a system with redundant information may result in inefficient decisions, to which *lack* of information may also lead. Theoretically, an *optimum* level of information will be reached if the marginal value of information equals its marginal cost. In reality, such costs and benefits can hardly be expressed by one common denominator, so this marginality rule has only a limited practical relevance. The various aspects involved in judging the value of an information system normally require to be treated in a multidimensional trade-off (to be discussed later).

An information system may also be useful for identifying the *minimum* requirements for making a decision. If the information level is too low, it may be appropriate to postpone a decision in order to collect more reliable data, unless the costs of postponing would be higher than the expected benefits of gathering better information. This principle of *trichotomous segmentation* is extensively discussed by Roy (1981). In conclusion, information systems may not only serve as decision support for making actual choices, but may also indicate the *margins* within which choice may be justified on scientific grounds.

3. The Nature of Data

The importance has already been mentioned of the trade-off between the costs of producing relevant information and the benefits of using it effectively in planning procedures and policy decisions. Therefore, we should pay attention to the nature of data that are appropriate for information systems.

Phenomena that are studied using social sciences can be described in various ways; for instance, by means of theoretical constructs (e.g. the level of welfare or the quality of life) or by means of operational concepts (e.g. the level of income or the amount of pollution). In the phase of theorizing on problems to be analyzed, the theoretical constructs are usually called *latent variables*. These variables do have a certain (sometimes intuitive) meaning, but cannot be directly measured. However, during hypothesis testing, empirical analysis, or model building one needs observations of *operational variables*, which are often proxy measures for latent variables. The literature on latent variables is fairly rich (e.g. Goldberger 1972, Goldberger and Duncan 1973, Aigner and Goldberger 1977, Folmer 1983).

More recently a great deal of attention has been given to explanatory analyses of latent variables; for instance, by means of indirect methods, like path analysis (e.g. Duncan 1975, Leitner and Wohlschlägl 1980, Jöreskog and Wold 1982), or by means of partial least squares (e.g. Wold 1975, 1983) or by means of linear structural equation models (Jöreskog 1977). The state of the art demonstrates that both latent and observable variables can be dealt with in empirical statistical and econometric analyses.

It should be added, however, that even operational and measurable variables may pose validity problems, as they have to be adjusted to specific analytic issues. For instance, if one has to examine the relationship between regional value added and the availability of transport infrastructure, the variable representing transport infrastructure has to be *standardized* in a meaningful way, for instance by relating it to the actual use of infrastructure, to the number of regional inhabitants, or to the regional activity density (Nijkamp 1983). Thus, each standardization includes a certain arbitrary or subjective value judgment that may have a substantial impact on the final results. In conclusion, even apart from measurement problems *per se*, defining an operational concept or variable in data analysis is far from easy.

Data for use in planning can be collected at various levels and according to various viewpoints. From an ideal point of view, the nature of data is determined by the aims of the analysis (e.g. impact analysis or plan evaluation), but in reality one very often has to use an existing data base in the most efficient way to extract the most relevant information for a specified use. For instance, it appeared from a recent international survey of multiregional economic models that specific data bases were not developed for the majority of the models, but instead the existing data provided by various statistical offices were employed in most cases (Issaev *et al*. 1982).

In general, data can be measured on different scales (Harvey 1969, Roberts 1979). Two major measurement scales are the *qualitative* (nonmetric) and the *quantitative* (metric) scale. (A thorough formal treatment of measurement theory can be found in Roberts (1979).)

A qualitative scale can be either nominal or ordinal:

- *Nominal scale*: a classification of attributes of observed variables into distinct groups (e.g. green or red) or into distinct size classes (e.g. small impacts, large impacts); a binary system can be a special case of this class of scale.
- *Ordinal scale*: a ranking of events or effects in order of magnitude (e.g. 1,2,3,...); a difference between ordinal figures has no quantitative meaning.

A quantitative scale can be based on either interval or ratio:

- *Interval scale*: a measurement system that allows a calculation of metric distances between figures, though the figures themselves do not have an absolute meaning.
- *Ratio scale*: a measurement system in which figures have an absolute numerical meaning, so that they can be represented in a normal metric system.

These four scales can be described more formally as follows. If e is an empirical system, N a numerical, real-valued system, and X a homomorphism for any relation (or operation) in e, then a scale may be defined as

$$X: e \rightarrow N .$$

X is therefore a variable representing a homomorphic mapping from an empirical to a numerical system. If now X and X' are both homomorphisms of e mapped into N (i.e. scales for a given e), then the four scales can be classified according to the kind of admissible transformation between X and X'.

Nominal: if and only if X' preserves the identity of X.
Ordinal: if and only if X' preserves the order of X.
Interval: if and only if $X' = cX + b$ $(\forall c \in \{\text{real numbers}\}, c > 0)$.
Ratio: if and only if $X' = cX (\forall c \in \{\text{real numbers}\}, c > 0)$.

In the past, the majority of concepts, attributes, or variables in the social sciences have been defined on a quantitative scale, but recently much effort has been put into the development of qualitative (or "soft") data methods (e.g. Wrigley 1980, Brouwer and Nijkamp 1981, Nijkamp and Rietveld 1982, Nijkamp *et al.* 1983). Nonparametric statistical tools (such as rank correlation methods), multidimensional and homogeneous scaling methods, log–linear analysis, logit and probit analysis, contingency table analysis, soft modeling, and linear structural equation models with latent variables have contributed to a valid and operational treatment of qualitative data. Similar developments can be found in plan evaluation methods

(Nijkamp 1980, Rietveld 1980, Voogd 1983). However, one of the crucial problems is that of mixed data (measured on different scales), which leads to the question of scale conversion.

The above-mentioned approaches in qualitative statistics and econometrics may be used for various purposes: measurement of the performance of a system, even if only qualitatively measured variables are available; detection of associations between qualitative variables; and modeling of causal patterns, for instance by designing a behavioral model for qualitative variables.

In various research fields (e.g. transportation behavior, housing and migration analysis, and mental maps) these modern analytic tools have already demonstrated their abilities. It should be emphasized that imprecise data, even when expressed qualitatively (e.g. linguistic statements in a fuzzy-set context), may provide meaningful information and hence should not be omitted.

Production of data is a problem in itself. Normally data are collected for several purposes, so it is usually difficult to obtain data that have a distinct focus on a particular research or planning problem. They often have to be manipulated, (dis)aggregated, or adjusted to suit the nature of the problem (Batty and Sikdar 1982).

Data can be collected at various levels of aggregation, for instance at individual levels (e.g. household income) or at aggregate levels (e.g. average regional income). Such data may result from interviews, questionnaires, censuses, samples, surveys, remote sensing, or other techniques. The choice of data collection technique and level of aggregation will be determined by the aims of the planners and will also depend on the trade-off between costs and expected usefulness (Park *et al.* 1981). The loss of information due to an aggregate representation of disaggregate variables can be represented by the *entropy*, which measures the degree to which microscale variables are ignored when one knows only a macroscopic variable (Gokhale and Kullback 1978). An intriguing problem of consistent aggregation and of information loss emerges if data are to be used at different spatial levels of aggregation (discussed in Chapter 13).

Another important problem is of course that one is usually interested in measures describing not only the state of a system but also its evolution. The latest data on complex systems, however, are normally hard to obtain because of the high costs of a permanent filing system, although modern monitoring and retrieval systems may be very helpful. Sometimes interpolation or extrapolation techniques are used to cope with the lack of data in a time series. Other common techniques for updating (spatial) data sets are biproportional RAS techniques (for input–output tables) and entropy techniques (for spatial interaction data). It is clear, however, that none of these techniques will be able to reflect sudden shifts in a system. In view of all the uncertainties in dealing with data corresponding to various spatial scales, a systematic investigation of the characteristics and uses of regional information systems would be valuable. This will be touched upon in Chapter 2.

4. A Systems View of Information Systems

Information systems for planning purposes serve to provide insight into the feasibility and desirability of various strategies that may be distinguished in choice problems. Since planning is a complicated activity, with many stages, it is important to obtain a distinct overall view, otherwise uncoordinated decisions may be taken. Therefore, a systems approach can be extremely valuable (Chadwick 1971), for it may offer a comprehensive picture of all information requirements. In general, the object of a systems approach is to portray the processes and relationships between the system components, which are connected by functional, technical, institutional, or behavioral linkages and which can also be influenced by changes in parameters or controls from the environment of the system (Sage 1977).

A formal systems representation of an information system can be made as follows. The set of profiles characterizing the successive parts of the system is denoted by $P = \{p_1, \ldots, p_N\}$, while the set of attributes of each profile $p_n (n = 1, \ldots, N)$ (such as the set of goal variables) is denoted by $A_n = \{a_{n1}, \ldots, a_{nI}\}$. The set of all attributes over all profiles may thus be represented by $A = \{A_1, \ldots, A_N\}$. This is essentially a set of impacts.

We may also introduce a set of exogenous policy fields and autonomous forces, $E = \{E_1, \ldots, E_J\}$, which constitute part of the environment of the system. The specific policy measures associated with each policy field $E_j (j = 1, \ldots, J)$ can be included in a set $B_j = \{b_{j1}, \ldots, b_{jM}\}$; the set of all b_j is represented by $B = \{B_1, \ldots, B_J\}$. Thus B may be regarded as a set of impact generators. Altogether the components of the whole system are denoted by $\{A, B\}$.

The processes and relationships can be dealt with in a similar manner by means of intermediate variables and parameters. If $s_{ni}^{n'i'}$ represents the relationship between elements a_{ni} and $a_{n'i'}$ within the system, then the set of internal relationships can briefly be represented as $S = \{s_{ni}^{n'i'}; \forall n, n', i, i'\}$. If r_{ni}^{jm} represents the relationship between any element a_{ni} within the system and any element b_{jm} outside the system, then the relationships describing the impacts of (external) policies upon the elements of the (endogenous) profiles can be denoted as $R = \{r_{ni}^{jm}; \forall n, i, j, m\}$. The following representation of an information system U can then be given: $U = \{A, B, S, R\}$. This expression can be seen as a formal definition of an information system. The sets of relationships and interactions, S and R, may include all kinds of relationships (series, parallel, feedback, compound). The structure of such a system is shown schematically in Figure 1.

It is evident that such an information system requires data on sets S and R, as well as on sets A and B. These relationships might be represented by means of a formal econometric model (estimated by means of time series or cross-section data) or by means of graphs or arrows (Brouwer and Nijkamp 1983). The latter approach is more modest,

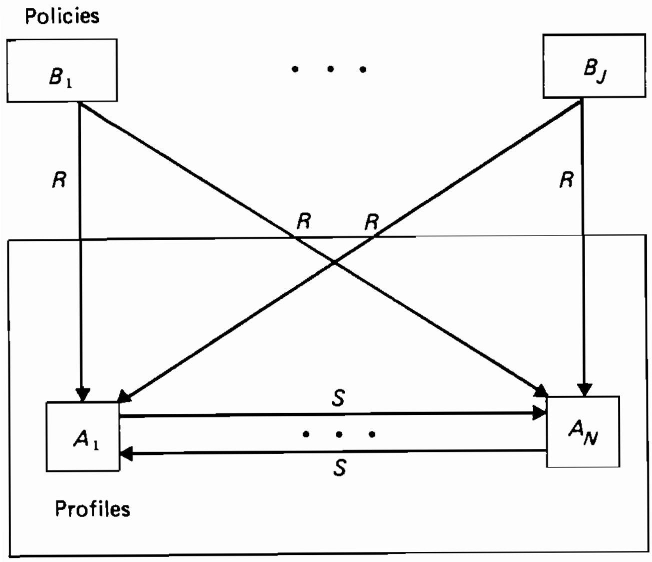

Figure 1 Simple representation of an information system.

as it does not require the construction of a comprehensive econometric model. In such cases, however, frequently only qualitative statements about the responses of the system to policy measures can be made. Nonetheless, less precisely measurable impacts may constitute useful components of a planning information system (Kahnemann *et al.* 1982).

5. Information Systems and Policy Analysis

It was argued earlier in the chapter that information systems provide a coherent and empirical basis for planning and decision making. If one defines policy analysis as a systematic investigation of elements, features, structures, linkages, conflicts, and effects inherent in choices or courses of action, it is clear that information systems are part of this. Also, such systems, ranging from a systematic presentation of data to advanced statistical and econometric modeling techniques, are necessary for policy formulation (Bauer 1968). Thus, policy orientation and problem orientation are key concepts in information systems.

In the present study, policy making refers to decision-oriented planning (Bahrenberg and Fischer 1981). Examples of this can be found in synoptic planning and rational comprehensive planning, while related approaches can be found in incremental planning and mixed-scanning approaches. Nevertheless, other kinds of planning (e.g. the social cybernetics and political economy approaches) need information systems to provide the necessary input, throughput, and output for complex social choice problems. In this respect, information systems may also form a unifying frame of reference in empirical planning problems.

In general, a series of stages may be identified in any policy-making process (Mayer and Greenwood 1980), as shown in Figure 2. In almost all stages, data and information play a central role. This scheme is useful for both *ex ante* policy analysis (which course of action is most suitable?) and *ex post* policy analysis (has the actual choice been most suitable?).

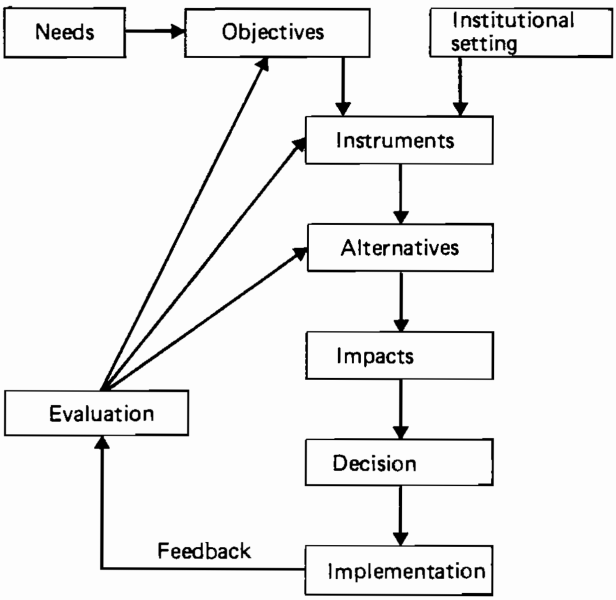

Figure 2 Stages of policy making.

Figure 2 contains a conflict between generality and specificity of information systems. It is sometimes claimed that it is appropriate to design general comprehensive information systems that can serve all the various needs of planners and decision makers. This, however, might imply a waste of resources, since the costs of a large amount of software and of collecting the necessary data might easily exceed the benefits of having all relevant information available in case of emergency or necessity. This is a matter of risk aversion, in which the costs of an uncertain future have to be traded off against the costs of a waste of resources.

In contrast, one might design specific information systems that are able to help planners and policy makers on specific problems. In such a situation, the information analyst has to make sure that he can provide adequate and flexible support on time. Specific information systems are easier to handle and less expensive, but they may have an *ad hoc* nature and may not always be available when needed.

Between these two extremes has appeared in recent years a new kind of information system, the *adaptive* information system. There are various reasons why this may be more appropriate than the other kinds. First of all, the assumption behind adaptive information systems is that planning and policy making are processes, so that a certain problem orientation with regard to a specific situation is placed in a long-term and coherent perspective, taking into account interactions between decision makers, individuals, and interest groups, Secondly, adaptive information systems can easily be linked to a systems view of planning, in which feedback effects provide a flexible frame of reference. In addition, an adaptive view provides more possibilities for establishing a scientific foundation of information systems, for instance by including notions from decision theory, conflict theory, economics, political science, geography, and planning theory. All these disciplines may also be important for identifying the principal mechanisms of social, economic, and spatial developments that may make up the central components of an information system. Finally, adaptive information systems may be more future-oriented, being based on past trends and because they may include a prospective view of obstacles and opportunities involved in new developments.

Clearly, a wide variety of problems are of concern to regional planners, statisticians, and regional scientists. For example, are we in a position to predict how the regional economies in western societies are reacting to the current structural and technological changes in industrial activity? In what sense are regional development strategies hampered by the absence of data? How have the demands for (regional) policy monitoring and evaluation been precluded by inadequate (regional) information systems? There is, of course, a danger that certain areas of planning may be covered more than others in a systematic investigation because certain data are available. Information systems should try to fill the information gaps as much as possible in order to achieve a balanced provision of relevant data for a comprehensive planning effort (Chadwick 1971).

There may be a discrepancy between a planning-oriented and a future-oriented view of information systems because the topics of interest to the planner may not match those emphasized in a given information system; in particular, if there is a long time lag, there will be less overlap between the information system and the planning activities (Figure 3). Problems that are hard to foresee can also lead to a lack of overlap. For instance, the sudden emergence of the energy crisis at the beginning of the 1970s revealed a basic weakness in energy information systems. Even now behavioral analyses and modeling of energy problems are hard to undertake because of a lack of detailed time series on energy demand and/or supply. The same holds true for the current interest in innovation policies; reliable data on industrial innovations (e.g. patent statistics) are hard to obtain.

These examples illustrate that information systems should not just be built according to current planning interests, but should include new components that are not yet receiving much attention but may become

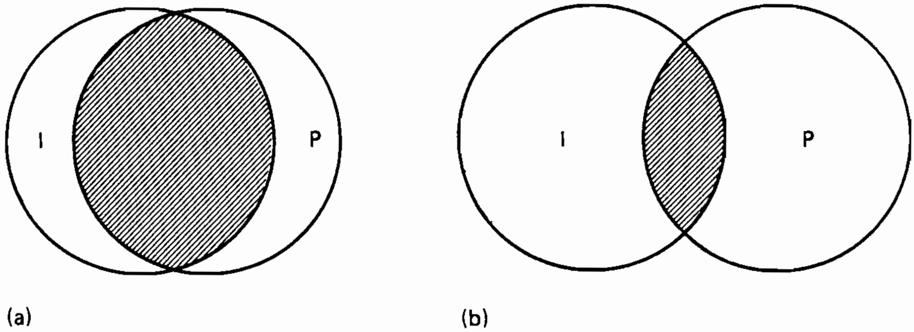

Figure 3 Overlap of planning fields (P) and information systems (I) in the case of (a) short-term planning and (b) long-term planning.

important in the future. Examples are: consequences of pollution, matters of conflict between different public agencies, regional influences of multinational companies, impacts of industrial reorientation, spatial aspects of the growing importance of agriculture, and consequences of microelectronics. It may be important to concentrate also on longitudinal discrete data, as they may reveal patterns of structural change and may offer more perspectives for behavioral analyses.

This future-oriented view of information systems requires an integrative framework for analyzing a complex socioeconomic system. Not only direct stimulus–response patterns, but also the conditions (social, political, institutional) under which certain policy stimuli may become effective, are important elements to identify (Dye and Gray 1981).

Wilbanks and Lee (1983) mention five bottlenecks in the application of results of scientific analysis to policy making:

- the lack of tailor-made scientific tools for various policy issues, caused by the time constraints prevailing in policy making;
- the discrepancy between basic scientific research and the needs of planners and politicians;
- gaps in our knowledge (e.g. about interaction effects across disciplinary boundaries, institutional uncertainties, and unforeseeable events);
- the lack of integration in scientific research, leading to piecemeal production of information; and
- insufficient learning from experience (especially from past failure).

It is evident that user–surveyor communication would help to remove the bottlenecks. It is important that the user or client is not disconnected from an information system, but it is equally important that an analyst is informed about the way a certain policy issue or problem is structured. Modern communication technologies provide, no doubt, enormous potential, although they cannot replace the contacts between user and analyst. In several choice situations, however, interactive simulation experiments and computer graphics, designed by experts, can nowadays be used directly by decision makers and planners, bringing policy and analysis closer together. This issue will be treated further in Section 7 on information and decision theory.

6. Use of Information

Information as organized data systems can be used in three stages of the planning process: description, impact analysis, and evaluation.

6.1. *Description*

A description means a structural representation of the data relevant to a system. For instance, the work on social indicators may be regarded as an attempt to represent relevant features of a social system in a systematic way. The same holds true for environmental quality analysis.

In general, it appears meaningful to represent the main characteristics of a system by multidimensional profiles, each profile comprising a set of indicators (Nijkamp 1979). For instance, a regional system may be characterized by means of the following profiles:

Economic: production; investment; labor market; consumption, etc.
Housing: quantity of dwellings; quality of dwellings; quality of neighborhood; prices and rents, etc.
Infrastructure: accessibility (public and private transport); distance; mobility (migration, recreation), etc.
Finances: taxes; subsidies; public expenditures; distribution, etc.
Facilities: health care; cultural; social; recreational, etc.
Environment: air pollution; noise; sewerage systems; congestion; segregation; density, etc.
Energy: consumption; insulation of dwellings; central urban heating system; tariff system, etc.

Depending on the aim of a specific analysis, a choice has to be made from these profiles (including the level of measurement) in order to obtain an integrated view of the system. Such a descriptive view implies a transformation of data into structured information classes.

Profiles with detailed elements are relevant not only in regional economics but also in many other disciplines, such as environmental science, geography, and demography. In all of these disciplines there is a basic need for systematic storage and treatment of data (Blitzer *et al.* 1975, Hordijk *et al.* 1980, Rees and Willekens 1981).

6.2. *Impact Analysis*

The impacts of decisions and actions of public agencies may be far-reaching. In the last decade several types of impact analysis for planning and policy purposes have been developed: environmental impact analysis, social impact analysis, input–output analysis, technological impact analysis, urban impact analysis, and so on. Their main aim is more complete, systematic, and comprehensive information on the effects of public policy decisions or of exogenous shifts in the parameters of a system. Impact analysis will be defined here as a method for assessing the foreseeable and expected consequences of a change in one or more exogenous stimuli that exert effects on the elements of the profiles characterizing a system (Pleeter 1980, Finsterbusch and Wolf 1981, Nijkamp 1982). In general, impact analysis necessitates a transformation of first-order information into new information categories.

The need for impact analysis stems from various sources:

- A systematic inventory of consequences of public policy may lead to more justifiable policy decisions.
- An integrated impact analysis may prevent the omission of (potentially important) indirect or unintended effects from consideration.
- A comprehensive view of the organization of a system is required because of possible spillover effects and interactions between several components of the system.
- The hierarchical structure of many planning systems indicates the need for a multilevel impact analysis that can trace all relevant consequences at various levels.

Owing to the diversity and complexity of industrialized countries, coherent and balanced public policy strategies are usually fraught with difficulties. For instance, the integration and coordination of various aspects of physical–economic planning (such as public facilities, communication and infrastructure networks, residential housing programs, and industrialization programs) are often hampered by administrative friction, narrow, disciplinary approaches, lack of information, and political discrepancies. An impact analysis may help to generate more integrated and coordinated planning strategies, since such analysis describes systematically the effects of changes in control variables on all other components of a system. Consequently, an impact analysis should examine the variety, coherence, and institutional framework of the system in question. This means that economic, spatial, social, and environmental variables should be included as components of the system. Preferably, an impact analysis should be based on a formal model (Glickman 1980, Cavalieri *et al.* 1982). The demand for a broader frame of reference for policy decisions, based *inter alia* on private economic, socioeconomic, environmental, energy, equity, and spatial criteria, is a logical consequence of the elaborate structure of advanced societies.

The grouping of variables in an impact analysis may be based on similarities in effects (Friedrich and Wonnemann 1981). Examples of such effects are changes in spatial accessibility, changes in urban residential conditions, changes in social structure, and changes in the attractiveness of urban employment. Such responses may result from several stimuli (changes in control variables), such as urban housing programs, energy conservation programs, and construction of an infrastructure network.

Formally, the relationships between policy controls and their impacts may be represented by a (qualitative and quantitative) model that shows the structure of the system. In this way, indirect and multiplier effects can also be taken into account (Nesher and Schinnar 1981). Such models can be used for forecasting and simulation. Because of the diversity among the components of most social systems, the above-mentioned *multidimensional profile approach* is often a useful analytic method for considering systematically many different aspects of such systems.

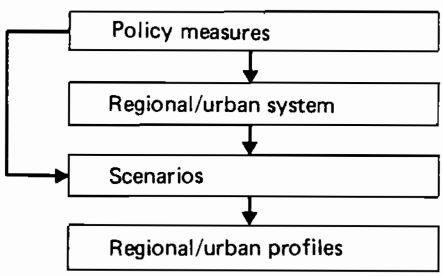

Figure 4 Stages of a regional/urban scenario analysis.

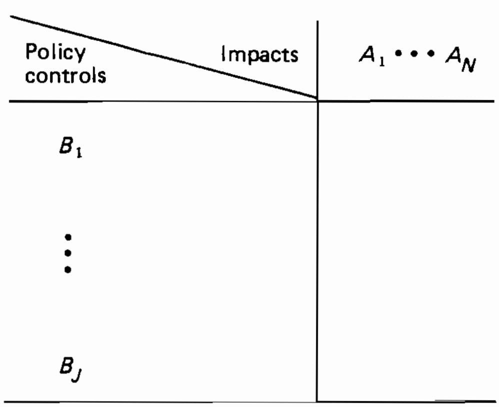

Figure 5 Impact structure matrix.

Any information system may be extended with a scenario analysis. A scenario analysis investigates the impacts of (hypothetical) policy measures by comparing these impacts with (or by judging them on the basis of) a reference profile based on policy targets or general objectives (Figure 4).

Sometimes it may be useful to employ an impact structure matrix (Figure 5) to represent the effects of policy controls ($B_1, \ldots, B_J$) on the systems components ($A_1, \ldots, A_N$). An example of a spatial interaction system that might provide the information necessary for an impact structure matrix is shown in Figure 6.

It has to be added that the dynamics of such a (spatial) impact system may be the result of several forces: autonomous developments (e.g. capital formation), exogenous developments (e.g. a rise in oil prices), and policy measures (at or above the systems level).

6.3. *Evaluation*

Evaluation consists of analyzing plans, proposals, or projects to find their comparative advantages and disadvantages, and of setting down the results in a logical framework. Thus, the essence of evaluation in planning is the assessment of the relative merits of different courses of action, so as to assist the process of decision making (Lichfield *et al.* 1975). Prior to the evaluation process it is necessary to perform the descriptive analysis and impact analyses, as described above. Evaluation essentially implies a comparison of structured information categories with policy and planning views.

Evaluation can take various forms: social cost–benefit analysis, cost effectiveness analysis, planning balance sheet analysis, multiple-criteria analysis, linear programming analysis, multiple-objective programming analysis, and so forth. A whole spectrum of evaluation methods has been developed (many of these appeared in the 1970s) to assess the pros and cons of various courses of action (see Section 7 and Nijkamp 1979).

For an evaluation it is necessary to define a set of operational judgment criteria (efficiency criteria, equity criteria, environmental criteria, etc.), a set of alternative actions or strategies (including information on their technical and economic feasibility), and a set of (implicit or explicit) preference parameters expressing the relative importance attached to each outcome of a given action or strategy. Sometimes scenario analyses are also used to deal with hypothetical, reasonable policy preference patterns. Figure 7 (which can be seen as an extension of Figure 2) shows the evaluation-associated linkages between the various stages of the planning process (Lichfield *et al.* 1975).

In order to make full use of information in evaluation and decision making, it is also necessary to indicate precisely the nature of the variables included (target variables, instruments, exogenous data), for each profile mentioned in Section 6.1. In general, it is also useful to specify how a certain desired result should be reached (cf. the golden section and turnpike rules). In order to prevent decision makers from taking

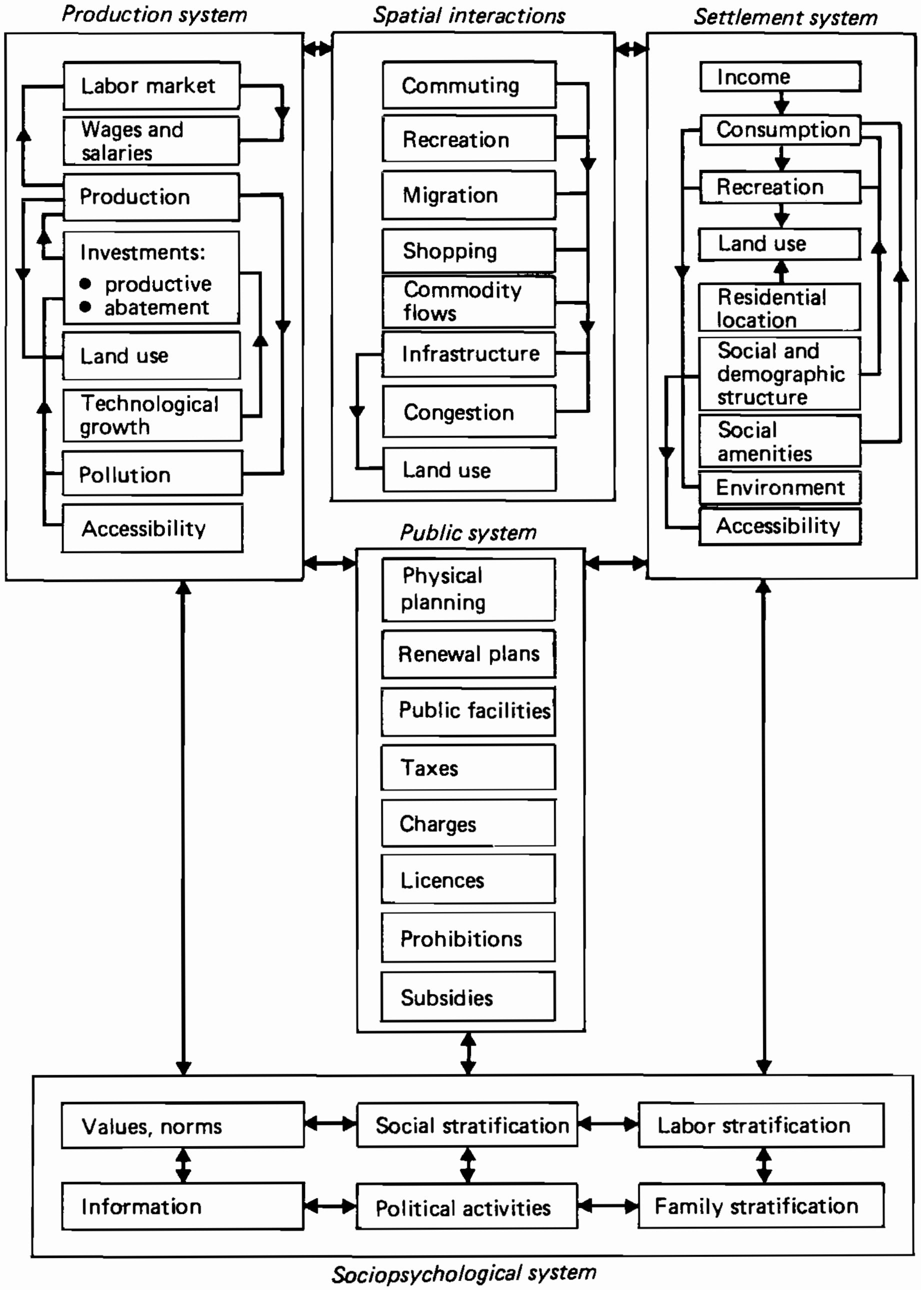

Figure 6 Illustration of a spatial interaction system (source: Nijkamp 1979).

infeasible courses of action, threshold analysis and bottleneck analysis may provide useful information about the conditions under which a certain new state of the system might evolve..

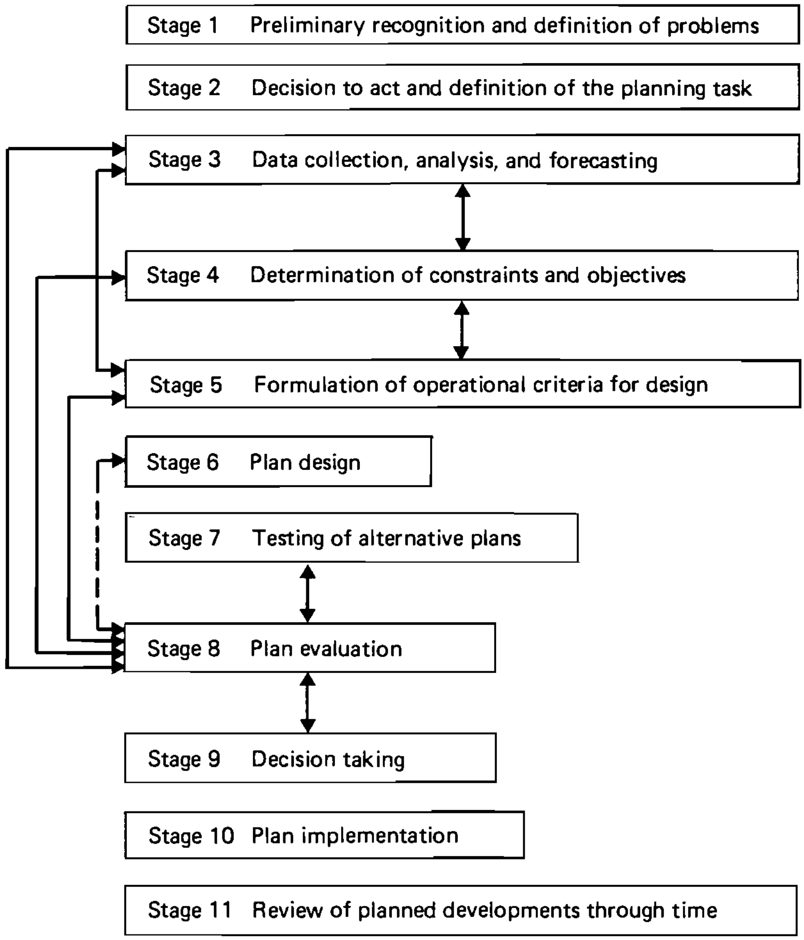

Figure 7 Linkages between stages in the planning process. Full arrow: formal evaluation-associated linkage; broken arrow: informal evaluation-associated linkage (based on discussion and liaison) (source: Lichfield *et al.* 1975, p. 40).

7. Information and Decision Theory

It has been shown in previous sections that information systems can provide the necessary input for all stages of policy making (Figure 2). The most intriguing is the decision stage, where a decision maker (or decision agency) makes a choice in favor of a certain course of action.

Information systems are meant to supply the decision maker with all information necessary for taking a rational decision. The concept of rationality does not imply that a rational decision is automatically a good (or even an optimal) decision; it only implies that a decision maker who has once taken a decision on the basis of a set of criteria would take the same decision in the future if all circumstances for taking the decision were the same. Thus rationality in decision making can only be tested in an *ex post* way, given the conditions of the choice problems at hand.

It is often assumed that decision making has a strict zero/one character: a decision maker may accept or reject a certain course of action. However, with information systems this strict assumption may be relaxed. In many situations it turns out that the available information is just insufficient to warrant a certain 0/1 choice because of the lack of knowledge of political priorities and expected consequences of some choice options. In addition to the yes/no option, another option enters the picture, namely to collect more information before a choice can be made. This trichotomous segmentation strategy implies that critical levels for the availability of information can be identified, below which no rational decision can be justified (Roy 1981).

In a decision framework, information systems are often considered only in terms of cost, against which one compares the improvement in the quality of decision. This is, however, only a partial view. Information systems may also have many benefits, as they may lead to avoiding the costs of taking wrong decisions. Thus the worth of an information system cannot be judged without evaluating the costs and benefits of all relevant courses of action.

There is, however, a problem in judging the outcomes of all choice actions because there is usually no common denominator by which one can compare all outcomes of alternative courses of action. Traditional evaluation methods, such as cost–benefit analysis, have failed to incorporate intangible effects, so that no integrated evaluation could take place. In this respect, modern multiple-criteria methods and multiple-objective decision methods are more promising (surveys have been published by, among others, Nijkamp 1979, 1980, Rietveld 1980, and Voogd 1983). These ***multidimensional choice models*** will be briefly discussed here in the context of information systems.

Let us imagine a set of decision criteria $w_1, \ldots, w_N$ ($\boldsymbol{w}$ in vector notation), each of which has a set of arguments $x_1, \ldots, x_I$ ($\boldsymbol{x}$ in vector notation). The vector $\boldsymbol{x}$ consists of endogenous variables and is determined by a set of exogenous variables $\boldsymbol{v}$ and a set of policy instruments $\boldsymbol{z}$. Thus the following decision problem may be formulated:

$$\text{maximize } w_1(\boldsymbol{x}), \ldots, w_N(\boldsymbol{x})$$

subject to

$$x = f(z, v) \ .$$

This multiple-objective method is based more on "optimizing" than on "satisficing" concepts (Simon 1960). In such cases, an information system should give more insight into:

- the precise definition of each decision criterion
- the components of x
- the components of z
- the components of v
- the response function of z and v to x
- the political priorities attached to the decision criteria
- the set of feasible and efficient solutions.

The level of detail of the above-mentioned impact model and of the decision criteria depends very much on the specific choice problems and on the available data. Modern statistical tools (like logit analysis and contingency table analysis) are able to deal with very disaggregate data. Usually only the poorest information on political priorities is available, although these variables are strategic parameters in a decision problem. Knowledge of these parameters is therefore of crucial importance, especially because the parameters will also determine the use that is made of results emerging from an information system. The selection of such results is mainly based on such priorities. One may even claim that, in the view of the decision maker, information systems should sometimes produce *uncertainty*. Depending on the issue and on the weights attached to the successive judgment criteria, a decision maker (or decision agency) may prefer more or less certainty.

These considerations confront the analyst with the problem of manipulation. In general, one may assume that a piecewise approach increases the probability of abuse of scientific analysis. Therefore, a suitable strategy may be to strive for an integrated and complete information system.

The problem of incommensurable decision criteria has also a positive aspect, as it increases the need for communication between decision maker and analyst, especially if there is too little information on political weights. In such cases, interactive strategies may be effective for reaching a compromise between conflicting decision criteria. This can be illustrated for a two-dimensional case, characterized by conflicting decision criteria w_1 and w_2. The feasibility spectrum (Pareto frontier or efficiency frontier) is represented by Figure 8.

In general, only points on the "efficiency frontier" are assumed to represent good solutions. This is a valid theoretical assumption, although in many practical cases decision makers appear to prefer less efficient (interior) solutions (Leibenstein 1978), because of lack of political insight,

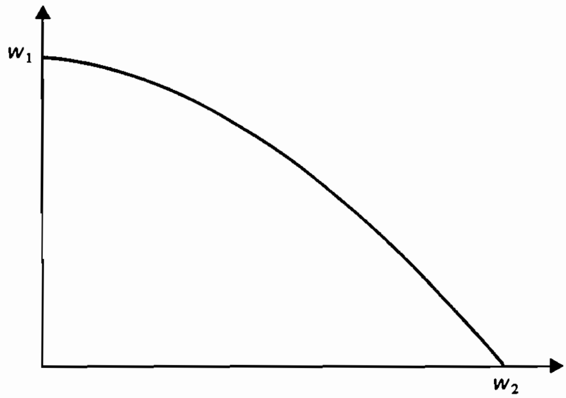

Figure 8 Feasibility spectrum for two conflicting decision criteria.

insufficient empirical data, or strategic considerations. (In the case of an efficient solution a policy failure can always be proved; in addition, an efficient point allows no further flexibility.)

If no information on political weights is available, interaction between analyst and decision maker may lead to a compromise decision on the conflicting criteria. Such a procedure is normally based on a dialogue between the analyst and the user, while a computer may serve to make the necessary quick calculations. The following steps can in general be distinguished:

(1) The analyst calculates a feasible trial solution.
(2) The user indicates whether or not he is satisfied with this proposal and suggests also in which direction a final compromise solution may be found.
(3) The analyst includes the latter information as a constraint in his analysis and calculates a new trial solution.
(4) The whole procedure is repeated until a converging compromise solution is obtained.

Interactive multidimensional choice analyses have demonstrated their potential on many occasions, in both private and public planning (Spronk 1981). In combination with a computer, they form valuable ways of employing information systems in user–expert communication.

Several classes of multicriteria and multiobjective methods can be distinguished, depending on the problem and on the precision of the data:

- discrete or continuous policy problems;
- qualitative or quantitative policy problems: qualitative problems include nominal or ordinal information on impacts of alternatives or on priorities/weights, whereas quantitative problems are based on metric information;

- static or dynamic policy problems;
- multiperson (or multicommittee) or single-person (or single-committee) policy problems: in multiperson or multicommittee problems one has to take into account the variation in preferences, while one may also consider the possibility of a multilevel decision structure;
- evaluation problems based on the generation of efficient alternative solutions or on the selection of one ultimate alternative: in the first case the procedure aims at identifying only "nondominated" solutions, for which the value of one policy objective cannot be improved without reducing the value of a competing objective; in the second case the aim is to find one alternative that is considered satisfactory after the description of preferences. An intermediate problem is one based on a ranking of alternatives or on the identification of a set of dominating alternatives.
- single-step or process evaluation problems: the first category consists of finding the most satisfactory solution immediately at a certain point in time; the second category considers policy making as a process during which one may add successively more information so that the ultimate solution is identified in a series of successive steps.

Process planning often requires the use of interactive policy procedures. Interactive evaluation procedures are based on information exchange between the analyst and the decision maker, and are especially useful when the decision committee has not specified its preferences or weights. As mentioned before, this leads to the need for adaptive information systems.

In many decision situations one has to take a *hierarchical* decision structure into account. For example, a state government may influence the maximum share of a city budget spent for urban renewal. Multilevel decision problems have received much attention in the past, but thus far have not often been treated using multicriteria and multiobjective models (Nijkamp and Rietveld 1981).

Clearly, the size and content of the information systems depend very much on the specific nature of the planning problems. This will be discussed in the next section.

8. Information Systems and Management of Uncertainty

The decision maker should have adequate knowledge of the expected consequences of all courses of action. In general, however, there are many uncertainties involved in making choices. These uncertainties are related not only to the policy system itself or to its external environment (the "policy problem"), but also to the direct and indirect impacts of policy measures (the "analytic problem").

A basic part of an information system should be the assessment of uncertainties or risks associated with the outcomes of selected alternatives.* The probability of occurrence of a successful decision has to be judged against the anticipated net benefits of this decision (Figure 9). In particular, in a free market system, introduction into the market will lead to low benefits for promising decisions (characterized by a high success rate). In a formal sense the probability of success of a certain decision can also be approximated by means of the (reverse) variance of a probability density function for the outcomes of a decision. It is clear that decisions with a higher uncertainty or risk will only be taken if they are compensated by higher expected benefits. Consequently, risk and uncertainty analysis can also be an important component of an information system.

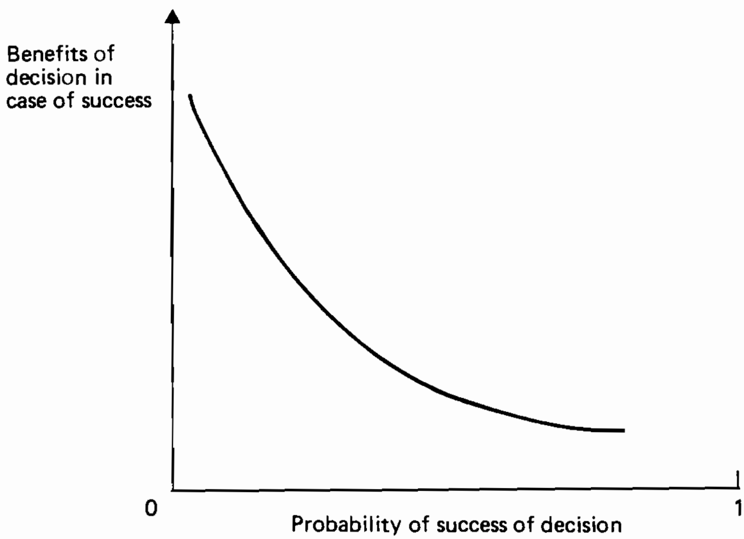

Figure 9 Revenue as a function of probability of success.

In general, the provision of information can have two consequences: the expectation of the outcomes of a decision (the anticipated benefits) and the variance of these events (the probability of failure) can be more precisely assessed; and, in the course of time, the expectation may be increased and the variance decreased. The latter observation is in agreement with the view of Braybrooke and Lindblom (1979), who have investigated the relationship between the impact (or depth) of a certain decision and the required information level (or level of knowledge). Figure 10 illustrates their conclusions.

* Formally, a risk situation implies that at least the probability density function of the outcomes of decisions is known, while uncertainty means lack of knowledge regarding the probability density function itself.

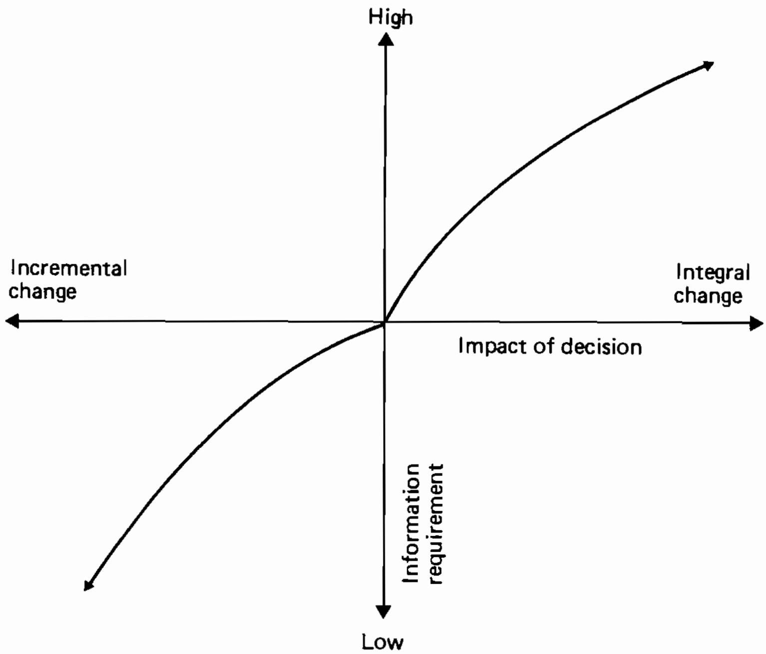

Figure 10 Relationship between information requirement and impact of a decision.

The notions of incremental and integral change from Figure 10 are often closely related to *unique* and *repetitive* choices. A unique choice situation means that a certain decision has not been taken before, so that the "actor" cannot rely on previous experience. Examples of such strategic choice situations are construction of a new airport or a new mass transit system, introduction of a new social security system, and implementation of a new energy-saving policy. In such situations it is extremely important to have information on all expected (direct and indirect) impacts in order to reduce uncertainty. Often the information has to be built up from nothing. In a repetitive choice situation, however, the decision maker may have information based on previous experience. Examples of such operational and managerial choice situations are daily operating decisions, and adjustments in a tax system. Repetitive choice situations do not require the construction of an entirely new information system, since a decision maker may use an existing data base, an available operational model, or an existing retrieval system. Thus, with the boundaries set by the choice problem, a unique choice situation leads to an integral change, whereas a repetitive choice situation normally implies only marginal (or incremental) changes.

The needs of actors in private and public institutions for information systems will thus depend very much on the nature of the problem. In general, their needs will be higher as:

- the frequencies of the choice situations are lower;
- the range of impacts is larger;
- the number of spillover (distributional) effects on other systems is larger;
- the number of conflicts is larger;
- the financial implications are more substantial;
- the time horizon of the impacts is longer;
- the number of decision agencies or actors is larger;
- the outcomes of choices to be made are more uncertain.

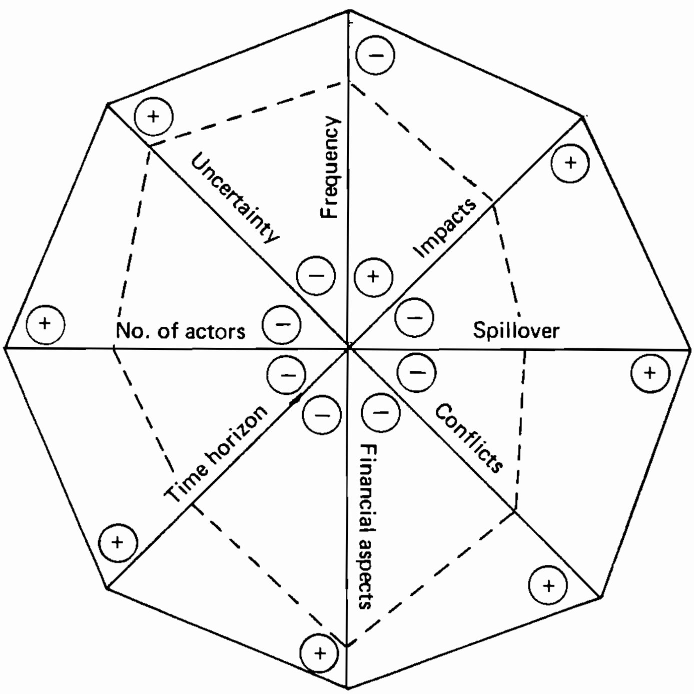

Figure 11 Demands on information systems according to the nature of the choice problem: +, high demand; −, low demand.

The previous remarks can be illustrated by means of Figure 11, which shows the demands on information systems as a function of these factors. Between the perimeter, representing maximum demand, and the center, reflecting minimum demand (e.g. routine decisions), is the actual situation, shown by the broken line.

The trade-offs between policy analysis, decision support, and information provision assume three objectives:

- maximum accuracy of input data (time series, disaggregate survey data, longitudinal data, etc.)
- maximum quality of the information system (efficiency, flexibility, coherence, etc.)
- the best possible organization of the choice problem (coordination, conflict management, public participation, etc.).

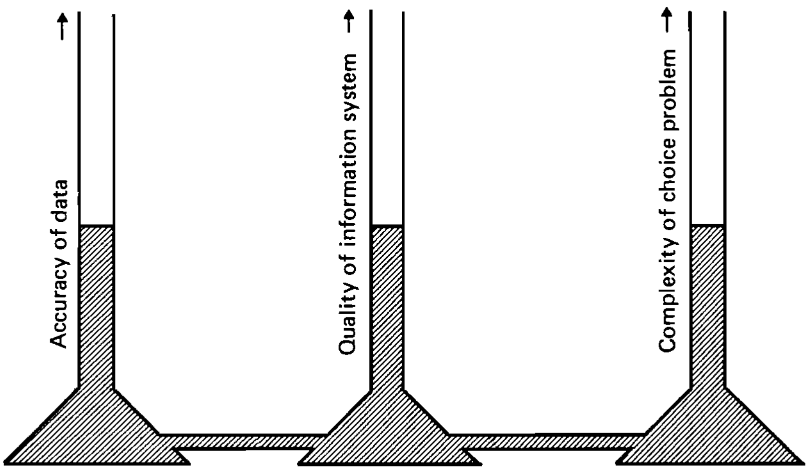

Figure 12 Trade-offs between the three objectives in a choice problem.

The trade-offs can be illustrated by means of a "flask model," in which three flasks are connected by glass tubes (Figure 12). The flasks are filled with water, while the three conflicting objectives are measured on the necks of the flasks. With a given amount of effort (a given quantity of water) it is seen that low accuracy of data will either demand a high-quality information system or will otherwise lead to a less organized choice situation. To design a good information system one must enhance the efficiency of data use and the effectiveness of policy choices, based on a well structured transformation of data into manageable policy information (by using *inter alia* man–machine interactions, knowledge-based systems, connecting networks, and decision support systems). Several of these issues will be discussed in other chapters of the book.

9. Outline of the Book

Part A of the book addresses general questions of spatially based information systems from the point of view of the planner. Chapter 2 (Nijkamp and Rietveld) pays special attention to the spatial element. This dimension gives rise to specific issues, such as the choice of spatial units, the description of spatial interactions, and the activities of planning agencies at various spatial levels. In Chapter 3, Peters discusses social and political aspects of regional information. He emphasizes that participants in the planning process may sometimes use regional information systems to resolve planning conflicts to their own advantage.

In Part B, the planning context of regional information systems is elaborated. In Chapter 4, Batey describes how the evolution of regional planning gave rise to a need for well developed information systems. Brown (Chapter 5) examines the relevance of information systems to the activity of monitoring in regional and urban planning. Hinloopen and Nijkamp give an account in Chapter 6 of methods to deal with uncertainty in planning. In Chapter 7, Dujnic, Issaev, and Slimak discuss the role of regional information systems in centrally planned economies. They point out the need for integrated information systems in countries where regional development is highly dependent on central planning. In Chapter 8, Lakshmanan presents a framework for multiregional information systems, and discusses its relevance as a basis for regional information systems in developing countries. For these countries he advocates development of information systems in stages because of limited budgets.

The contents of regional information systems receive more attention in Part C. Chapters 9 and 10, by Rietveld and by Hårsman, are devoted to two main components of regional information systems: the labor market and the housing market. The next three chapters are concerned with the role of modeling in regional information systems. Chapter 11 (Courbis) discusses multiregional economic models, both as consumers and as producers of information. In Chapter 12, Bianchi, Johansson, and Snickars give a similar treatment to integrated regional modeling. In Chapter 13 (Nijkamp, Rietveld, and Rima), attention is paid to the level of spatial detail in regional models. It is shown that the choice of spatial scale is by no means trivial.

In Part D, technological aspects of data input, data storage, and information output are discussed. Johansson and Marksjö (Chapter 14) describe interactive computer programs for regional analysis of industrial sectors, taking into account confidentiality rules. In Chapter 15, van Est and de Vroege discuss the use of geocoding for manipulating data at a very high level of spatial detail. Peters, in Chapter 16, stresses that the spatial dimension gives rise to specific difficulties in data storage and retrieval and information production (e.g. cartographic output). Chapter 17 (Wigan) describes the rapid developments in information technology in recent years. The new opportunities that they offer have certainly not yet been fully exploited in the normal design of regional information systems.

Part E contains analyses of regional information systems in six countries. A general framework for the comparative study is given in Chapter 18 (Nijkamp and Rietveld). Chapters 19 to 24 describe regional planning and information systems in Sweden (Guteland and Nygren), France (Muguet), the United States (Garnick), the Netherlands (van Est, Scheurwater, and Voogd), Czechoslovakia (Drozd), and Finland (Janhunen). These national reports are reviewed by Hinloopen, Nijkamp, and Rietveld in Chapter 25.

The purpose of the final chapter, by Nijkamp and Rietveld, is to synthesize and summarize the contents of the book. The prospects of information systems for integrated regional planning are also discussed.

References

Aigner, D.J., and A.S. Goldberger (1977) *Latent Variables in Socioeconomic Models* (Amsterdam: North-Holland).

Bahrenberg, G., and M.M. Fischer (1981) Planungstheorien – Zur Kritik des handlungstheoretischen und des politökonomischen Paradigmas. *Klagenfurter Geographische Schriften* 2: 39–73.

Batty, M., and P.K. Sikdar (1982) Spatial aggregation in gravity models: Generalizations and large-scale operations. *Environment and Planning* A 14: 795–822.

Bauer, R.A. (1968) The study of policy formulation: An introduction. *The Study of Policy Formulation*, eds. R.A. Bauer and K. Gergen (New York, NY: Free Press), pp.97–111.

Blitzer, C.R., P.B. Clark, and L. Taylor (eds.) (1975) *Economy-Wide Models and Development Planning* (New York, NY: Oxford University Press).

Braybrooke, D., and C.E. Lindblom (1979) *A Strategy of Decision* (New York, NY: Free Press).

Brouwer, F., and P. Nijkamp (1981) Categorical spatial data analysis. *Research Memorandum* 1981–22, Department of Economics, Free University, Amsterdam.

Brouwer, F., and P. Nijkamp (1983) Qualitative structure analysis of complex systems. *Measuring the Unmeasurable: Analysis of Qualitative Spatial Data*, eds. P. Nijkamp, H. Leitner, and N. Wrigley (The Hague: Martinus Nijhoff).

Burch, J.G., F.R. Strater, and G. Grudnitski (1979) *Information Systems: Theory and Practice* (New York, NY: Wiley).

Casley, D.J., and D.A. Lury (1981) *Data Collection in Developing Countries* (Oxford: Clarendon).

Cavalieri, A., D. Martellato, and F. Snickars (1982) A model system for policy impact analysis in the Tuscany region. *Paper* presented at Task Force Meeting on Tuscany Case Study, International Institute for Applied Systems Analysis, Laxenburg, Austria, 6–7 December.

Chadwick, G. (1971) *A Systems View of Planning* (Oxford: Pergamon).

Debons, A., and A.S. Larson (eds.) (1983) *Information Science in Action: System Design* vols. I, II (The Hague: Martinus Nijhoff).

Duncan, O.D. (1975) *Introduction to Structural Equation Models* (New York, NY: Academic Press).

Dye, T.R., and V. Gray (eds.) (1981) *The Determinants of Public Policy* (Boulder, CO: Westview).

Finsterbusch, K., and C.F. Wolf (eds.) (1981) *Methodology of Social Impact Assessment* (Stroudsburg, PA: Hutchinson Ross).
Folmer, H. (1983) Measurement of effects of regional economic policy. *Ph.D. Dissertation*, Department of Economics, University of Groningen.
Friedrich, P., and H.G. Wonnemann (1981) Manual for identifying the effects of the settlement of a public office. *Locational Developments and Urban Planning*, eds. W.F.J. van Lierop and P. Nijkamp (The Hague: Martinus Nijhoff), pp. 389–406.
Glickman, N.J. (1980) Impact analysis with regional econometric models. *Economic Impact Analysis*, ed. S. Pleeter (Boston, MA: Martinus Nijhoff), pp. 113–128.
Gokhale, D.V., and S. Kullback (1978) *The Information in Contingency Tables* (New York, NY: Dekker).
Goldberger, A.S. (1972) Structural equation models in the social sciences. *Econometrica* 40: 979–1002.
Goldberger, A.S., and O.D. Duncan (eds.) (1973) *Structural Equation Models in the Social Sciences* (New York, NY: Seminar Press).
Harvey, D. (1969) *Explanation in Geography* (London: Arnold).
Hordijk, L., H.M.A. Jansen, A.A. Olsthoorn, and J.B. Vos (1980) Reken en Informatiesysteem Milieuhygiene. *Report*, Institute for Environmental Studies, Free University, Amsterdam.
Issaev, B., P. Nijkamp, P. Rietveld, and F. Snickars (eds.) (1982) *Multiregional Economic Modeling: Practice and Prospect* (Amsterdam: North-Holland).
Jöreskog, K.G. (1977) Structural equation models in the social sciences: Specification, estimation and testing. *Application of Statistics*, ed. P.R. Krisnaiah (Amsterdam: North-Holland), pp. 265–287.
Jöreskog, K.G., and H. Wold (eds.) (1982) *Systems Under Indirect Observation* (Amsterdam: North-Holland).
Kahnemann, D., P. Slovic, and A. Tversky (1982) *Judgement under Uncertainty: Heuristics and Biases* (New York, NY: Cambridge University Press).
Leibenstein, H. (1978) *Beyond Economic Man* (Cambridge, MA: Harvard University Press).
Leitner, H., and H. Wohlschlägl (1980) Metrische und ordinale Pfadanalyse. *Geographische Zeitschrift* 68(2): 81–106.
Leontief, W.W. (1982) The international use of input–output analysis. *The International Use of Input–Output Analysis*, ed. R. Stäglin (Göttingen: Vandenhoeck and Ruprecht), pp. 19–26.
Lichfield, N., P. Kettle, and M. Whitbread (1975) *Evaluation in the Planning Process* (Oxford: Pergamon).
Mayer, R.R., and E. Greenwood (1980) *The Design of Social Policy Research* (Englewood Cliffs, NJ: Prentice-Hall).
Nesher, A., and A.P. Schinnar (1981) Neighborhood and program multipliers of public-funded community development activities. *Locational Developments and Urban Planning*, eds. W.F.J. van Lierop and P. Nijkamp (The Hague: Martinus Nijhoff), pp. 408–431.
Nijkamp, P. (1979) *Multidimensional Spatial Data and Decision Analysis* (New York, NY; Chichester: Wiley).
Nijkamp, P. (1980) *Environmental Policy Analysis* (New York, NY; Chichester: Wiley).
Nijkamp, P. (1982) Regional planning and urban impact analysis. *Essays in Honor of Martin J. Beckmann*, ed. R. Funck. Karlsruhe Studies in Regional Science (forthcoming).
Nijkamp, P. (1983) A multidimensional analysis of infrastructure and regional development. *Structural Economic Change and Planning in Space and Time*,

eds. A. Åndersson *et al.* (Amsterdam: North-Holland)(forthcoming).
Nijkamp, P., H. Leitner, and N. Wrigley (eds.) (1983) *Measuring the Unmeasurable: Analysis of Qualitative Spatial Data* (The Hague: Martinus Nijhoff).
Nijkamp, P., and P. Rietveld (1981) Multiobjective multi-level policy models. *European Economic Review* 15: 63–89.
Nijkamp, P., and P. Rietveld (1982) Soft econometrics as a tool in regional discrepancy analysis. *Papers of the Regional Science Association* 48:1–21.
Park, S.H., M. Mohtadi, and A. Kubursi (1981) Errors in regional nonsurvey input–output models. *Journal of Regional Science* 21(3):221–229.
Pleeter, S. (1980) *Economic Impact Analysis* (Boston, MA: Martinus Nijhoff).
Rees, P. and F. Willekens (1981) Data bases and accounting frameworks for IIASA's Comparative Migration and Settlement Study. *Collaborative Paper* CP-81-39, International Institute for Applied Systems Analysis, Laxenburg, Austria.
Rietveld, P. (1980) *Multiple-Objective Decision Methods and Regional Planning* (Amsterdam: North-Holland).
Rittel, H. (1982) Structure and usefulness of planning information systems. *Human and Energy Factors in Urban Planning*, eds. P. Laconte, J. Gibson, and A. Rapoport (The Hague: Martinus Nijhoff), pp. 53–64.
Roberts, F.S. (1979) *Measurement Theory* (Reading,MA: Addison-Wesley).
Roy, B. (1981) A multicriteria analysis for trichotomic segmentation problems. *Multiple Criteria Analysis*, eds. P. Nijkamp and J. Spronk (Aldershot: Gower), pp. 245–258.
Sage, A.P. (1977) *Methodology for Large-Scale Systems* (New York, NY: McGraw-Hill).
Scheele, R.J. (1983) Making plans work. *Ph.D. Dissertation*, State University, Utrecht (forthcoming).
Simon, H.A. (1960) *The New Science of Management* (New York, NY: Harper and Row).
Sowell, T. (1980) *Knowledge and Decision* (New York, NY: Basic Books).
Spronk, J. (1981) *Interactive Multiple Goal Programming for Capital Budgeting and Financial Planning* (Boston, MA; The Hague: Martinus Nijhoff).
Theil, H. (1967) *Economics and Information Theory* (Amsterdam: North-Holland).
Voogd, H. (1983) *Multicriteria Evaluation for Urban and Regional Planning* (London: Pion).
Webber, M.J. (1982) *Information Theory and Urban Spatial Structure* (London: Croom Helm).
Wilbanks, T. J., and R. Lee (1983) Policy analysis in theory and practice. *Assessing Regional Consequences of Large-Scale Energy Projects: An International Comparison of Experiences with Models and Methods*, eds. T.R. Lakshmanan and B. Johansson (to be published).
Wold, H. (1975) Soft modelling by latent variables. *Perspectives in Probability and Statistics*, ed. J. Gassi (London: Academic Press), pp.117–142.
Wold, H. (1983) Systems analysis by partial least squares. *Measuring the Unmeasurable: Analysis of Qualitative Spatial Data*, eds. P. Nijkamp, H. Leitner, and N. Wrigley (The Hague: Martinus Nijhoff).
Wrigley, N. (1980) Categorical data, repeated measurement research designs, and industrial surveys. *Regional Studies* 14: 455–471.

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CHAPTER 2

Spatially Oriented Information Systems

Peter Nijkamp and **Piet Rietveld**

1. Urban and Regional Policies and Information Systems – A Preface

During the seventies, local and regional governments became increasingly aware of the problems of urban decay and regional inequality, and of the inadequacy of urban and regional policies to combat the adverse effects of urban and regional development. In general, urban and regional policies are diverse, as far as targets, instruments, and institutional contexts are concerned. In general, such policies aim at realizing a supply profile of urban and regional facilities and services that is consistent with the perceptions and priorities of the people whom it concerns. Furthermore, these policies must take account of the positions of cities and regions in the total spatial structure (Nijkamp and Rietveld 1981).

Usually, urban and regional policies have a wide variety of objectives, which may sometimes be represented by a *target profile*. Normally, there are also several policy instruments (revenues and expenditures such as taxes and subsidies; prohibitions, etc.) that can be related to various urban and regional sectors, such as industry, the housing market, the transportation system, the quality of life, social welfare programs, and the energy system. The policy objectives and instruments should relate to both residential and entrepreneurial activities, as well as to mobility. The diversity of urban and regional development requires a multidimensional view of urban and regional policies that is much broader than a purely efficiency-oriented, monetary policy analysis (multiple-objective decision making is discussed in Section 7 of Chapter 1).

There are many interactions between developments in cities and regions, as well as between urban and regional policies. Regional growth policy, for example, may have tremendous impacts on the urban system in the region concerned; regional industrial incentives may have strong impacts on urban labor markets; a growth-center policy may, on the other hand, exert a substantial influence on regional growth. Therefore, the interaction of the urban and the regional economy has to be taken into account, so that several spatial scales (e.g. intraurban, interurban, intraregional, interregional, and national) have to be considered in urban and regional policy analysis. Under these circumstances the coordination and integration of regional and urban policies is a complex matter. Owing to spatial spillover effects, dynamic interactions, and increasing uncertainties, a spatial system of regions and cities shows an intricate and often unpredictable behavior. The control of this behavior via public policy measures is obviously difficult. Furthermore, one has to take account of different systems effects associated with bottom-up or top-down policies.

Clearly, a systematic and coherent insight into the complex patterns and evolution of a spatial system requires the design of an up-to-date, accessible, and comprehensive *spatial* information system. Information systems for urban and regional planning should contain organized data on actual development patterns, their properties (e.g. stability), and the links between them. Frequently, however, information systems concentrate on the national level or specific sectors. The *geographic* dimension of information systems as a decision aid in urban and regional development planning has too often been neglected. More attention should be given to design and development of information systems reflecting socioeconomic processes so that they better represent spatial systems and are better adapted to the needs of urban and regional planners (Blumenthal 1969).

The major aim of this chapter is to present in a systematic way a set of considerations that should underlie the design and use of information systems for urban and regional planning.

In general, spatially oriented data have two components, an *image* and an *attribute*. The image component represents the coded values describing the spatial position of an object or event, while the attribute component describes its other properties. Image data identify point locations, line segments, or boundaries in either a nominal or a metric code, whereas attribute data are usually coded by means of a measurement scale (nominal, ordinal, interval, or ratio, described in Chapter 1). It has become common practice in processing spatially oriented data to treat the image data and attribute data separately. Various types of spatial data and their representations can be distinguished in spatial information systems, such as features of attribute data, areal unit information, natural topological data, surface information, sampling data, graphic symbol data, and label text information.

As mentioned before, spatial systems are rather diverse in nature. A *profile approach* may thus be a useful way of producing an operational framework for a spatial information system by representing the elements of a planning structure in a coherent manner. Three kinds of profile may be distinguished.

- A *spatial* profile represents the geographic subdivision of cities and regions in a spatial system; for instance, the following profile may exhibit both a bottom-up and a top-down structure: region 1, including city A and city B; region 2, including city C. This profile is essentially an operational representation of the above-mentioned image component.

- A *sectoral* profile represents the fields of urban and regional planning. Examples are the labor market, education, transportation, and housing.
- A *facet* profile represents the aspects and judgment criteria of a certain urban or regional sectoral policy. Examples are financial aspects, land use, environmental effects, and energy effects.

Both the sectoral and facet profiles are quantitative representations of the above-mentioned attribute component. The spatial, sectoral, and facet profiles can be incorporated in a three-dimensional block matrix.

Thus far, the sectors have been treated independently of each other. This is, however, not realistic: sectors often have a mutual influence (e.g. transportation policy and urban renewal policy will affect the labor market). In addition, there are spatial impacts (e.g. urban renewal in a city will influence the transportation systems of the whole region and maybe those of surrounding regions). This interwoven pattern of development calls for an integrated and coordinated spatial policy.

The best way to describe such a complex pattern of regions, cities, sectors, and facets would be to construct an integrated spatial model. As this is usually impossible, at least in the short run, it may be more appropriate to assess the effects of separate or compound facet policies to be implemented in certain regions or cities, based on reliable information systems.

In the context of the present study, the following features and issues of a spatially oriented information system deserve special attention:

- the relevance of the systems view of information for regional development;
- the geographic division of a spatial system into many components (e.g. regions, cities);
- the use of models and statistical–econometric methods in regional planning;
- the power of modern computer approaches for regional planning; and
- the need for general conclusions and observations on information systems, based on an international study.

2. Geographic Information Systems

A wide variety of geographic information systems were designed in the 1970s, and the increased use of computers has favored systematic storage and processing of large amounts of data in these systems. Moreover, various cartographic techniques have been developed in recent years, such as color display and choropleth mapping (e.g. Tobler 1979, Steiner 1980). These techniques have to deal with such questions as the level of aggregation of objects for planning and policy issues, selection or elimination of data for solving a specific problem, the required degree of homogeneity or heterogeneity of attributes, and the design of similarity measures and significance tests (e.g. χ^2 distribution) (Sibert 1980, Grimmeau 1981, Thelander 1981). The level of detail (or aggregation) is sometimes a major problem in the design and use of geographic information systems.

Hermansen (1971) has formulated several criteria for a system of geographic data identification. Some of these are stated below:

- The system should be neutral with respect to particular real-world situations.
- The system should be flexible enough to permit both general and specialized subsystems of spatial units. It should allow transformations from one subsystem to another and the formation of new subsystems within the general system.
- The system should contain possibilities for the hierarchical ordering of units, i.e. the formation of vertical subsystems.

The criteria do not give precise guidelines for systems of geographic coding. Barraclough (1964) distinguished two systems of geographic data identification:

The name method attempts to classify elements localized in space and hence divides space into regions or areas that depend on the characteristics of the elements, for example the response to a questionnaire marked by the location of the respondent.

The location method establishes principles of spatial subdivision, by which the spatial system is then provided with geographic coordinates referring to any location within it.

If the name method is judged according to Hermansen's criteria, the following observations can be made (Willis 1972). (1) This method is unlikely to be spatially "neutral," because particular users spatially organize the data for their own special purposes. (2) The method has limited flexibility because the boundaries are determined in advance of any analysis. Transformation between one spatial subsystem and another can only be achieved with considerable effort and with a certain loss of information. (3) Each alternative aggregation of spatial units, though possible on the basis of individual spatial units, would require a lot of work. Spatial aggregations are possible but only with considerable effort. In conclusion, the name method is not very suitable for spatial data identification.

In general, location methods are regarded as more appropriate, especially one method called *geocoding*. The main goal of a spatially oriented information system like a geocoding system is to improve the organization of data and the display of information (Chapter 15). The geocoding system is fairly flexible, as it provides information on objects and attributes at any desired geographic scale within an area. Geocoding has been developed especially for detailed geological and cartographic work, but it has potential in regional planning. Its advantage is that the boundaries of aggregate areas can be drawn *after* the data are collected and processed. The data can be retrieved according to not just one set of boundaries, but according to several.

Geocoding appears to be a fairly flexible way of dealing with detailed geographic data. It may be an accessible tool for expert–user dialogue, while it may also be linked with computerized cartographic approaches. Its major strength is its strong spatial orientation, though a weakness is its static nature: a structural change in the spatial configuration will have a drastic impact on the information content of geocoding.

A very interesting and wide-ranging review of computer software for geographic information systems has been issued recently by the Commission on Geographical Data Sensing and Processing of the International Geographical Union (1980). The survey, published as three volumes (full geographic information systems, data manipulation programs, and cartography and graphics), was based on a systematic typology of many data and information systems and is a rich source of information and references on spatially oriented information systems.

The basic aim of the present study, however, is not to review spatially oriented information systems *per se* but to concentrate on the methodology, decision-making aspects, and the policy use of such systems for regional planning.

3. Regional Dimensions of Information Systems

Any spatial system can be subdivided into smaller spatial entities (regions, counties, cities, districts, etc.). However, the demarcation of these subdivisions is usually not unambiguous, since this can be determined by:

- the institutional–administrative structure of the system,
- the functional economic interactions and intensiveness of the system, and
- the availability of a spatially oriented data base.

In reality, the spatial demarcation for information systems is often based on a mixture of these influences.

From a systems view, one may characterize a spatial system by means of *nodes* and *edges*. The nodes represent the entities in the system, while the edges represent the various interactions. Nodes and edges may represent stocks and flows, respectively. A simple scheme of a spatial system is shown in Figure 1, which includes both top-down and bottom-up structures, the effects of external developments and of policy measures, and horizontal (regional) interdependences. In this sense, it has a multilevel, multiactor, and multiobjective planning structure (Chapter 1).

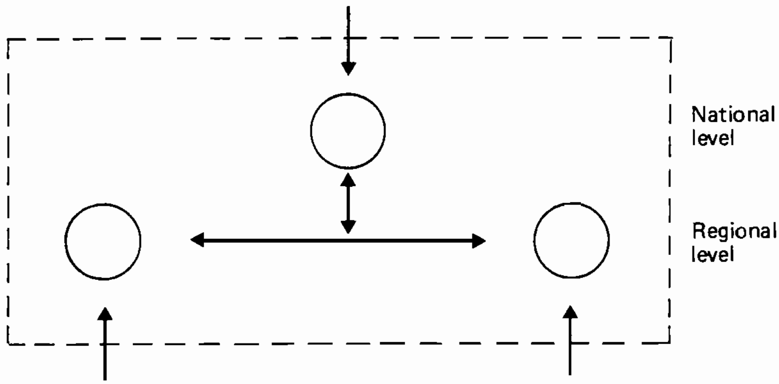

Figure 1 Nodes (circles) and edges (arrows) in a spatial system.

It may now be worth while to specify some general judgment criteria for an information system for regional planning.

Availability. The relevant information should be available during successive stages of the planning process, to guarantee an adequate picture of the system (including, possibly, longitudinal data).

Timeliness. The information should be based on recent data, to provide a representative and up-to-date picture of the complex real system.

Accessibility. The information should be accessible to both model builders and users (including policy makers and planners).

Consistency. The information should represent a set of coherent and uncontradictory data on regional processes and patterns.

Completeness. The information should take into account all important (intended and unintended) effects and implications of policies for the system.

Relevance. The information produced should be in agreement with the aims of regional (or urban) management and planning.

Multiformity. The variables in an information system should reflect the variety and multidimensionality of a multiregional system.

Comparability. The various data should allow a comparison with other data measured at different periods or in different areas.

Flexibility. The information systems should provide comprehensive information that can easily be adjusted to the needs of users or to new circumstances.

Measurability. The information system should accommodate the available regional data measured on any meaningful scale (including qualitative information).

Comprehensiveness. The various components of the information system should together provide an integrated picture of a multiregional system.

Effectiveness. The information should allow a comparison with regional policy targets set *a priori* so that the effectiveness of policy measures can be gauged.

Versatility. The information should also be usable for other planning purposes in the same region or elsewhere.

Validity. The reliability of the information and of the related statistical inferences should allow a judgment to be made from a statistical or econometric point of view.

This long list of criteria is normally not fulfilled in practice, but it may serve as a reference for designing or adjusting spatially oriented information systems.

In addition to these general methodological criteria, some specific regional or multiregional elements of a spatially oriented information system can also be mentioned (Willis 1972, Bowman and Kutscher 1980, Garnick 1980, Torene and Goettee 1980).

Integration. The information system should attempt to present relevant data for each relevant spatial level and spatial unit, to guarantee both comparability of data between regions and coordination of planning activities in different agencies.

Interregional interaction. The information system should reflect the interdependences within a spatial system by indicating the volumes of interregional commodity flows, migration flows, capital flows, etc.

Spatial spillover effects. The information system should pay attention to spillover effects in a dynamic multiregional open system, including spatial diffusion patterns through which new technological, social, and economic activities evolve.

Specific regional bottlenecks. The information system should indicate whether or why important regional information is lacking (e.g. the frequent lack of insight into monetary flows between regions).

Multiregional decision making. Various decisions affecting a regional economy are made in headquarters of corporate decision-making bodies; in addition, flows of income and profits are hard to attribute to a specific region. The information system should try to disentangle such complexity.

Standardization. For data to be comparable between regions, taking into consideration the different kinds of basic spatial units, they should be standardized (e.g. by relating them to population size or size of area). The information system should provide a sound basis for such a standardization and should also indicate the sensitivity of the results for a particular standardization (depending, among other things, on the social and demographic structure).

Many countries have developed spatially oriented information systems for regional development planning, though there is an enormous variation among information systems in different countries. A good example of an integrated multiregional information system can be found in the USSR planning system (Issaev 1982a). A condensed version of a multisectoral, multiregional planning system is shown in Figure 2, which gives the general configuration of SMOTR, the sectoral and regional model coordination system (Baranov and Matlin 1982). This configuration describes a sectoral–regional, top-down–bottom-up structure for the USSR economy. A spatially oriented information system should provide the basic information for such a planning system.

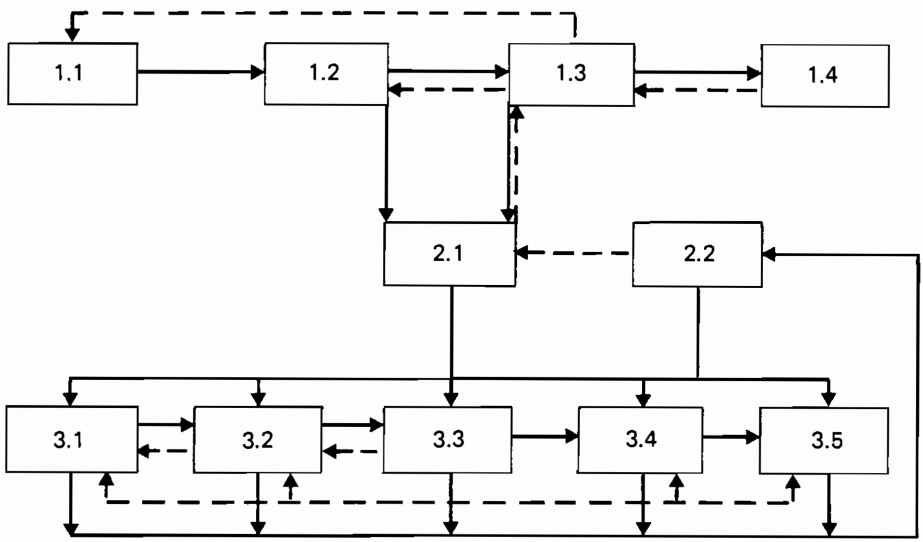

Figure 2 General configuration of SMOTR (sectoral and regional model coordination system). Full lines: direct links; broken lines: feedback links. 1.1, Overall macroeconomic indicators; 1.2, goal indicators for national economic development; 1.3, simulation dynamic input–output model (18 sectors); 1.4, interindustry flows model based on sectoral production functions; 2.1, dynamic model dealing with balances of interindustrial value flows (260 products); 2.2, "center" model; 3.1, models of separate industries and industrial complexes; 3.2, model for construction of industrial complex; 3.3, module of regional models; 3.4, module of transportation complex; 3.5, models of supply with intermediate goods (source: Baranov and Matlin 1982).

Other good examples of the contents of regional and urban information systems can be found in Hagerstrand and Kuklinski (1971), Kuklinski (1974), Perrin (1975), Benjamin (1976), Guesnier (1978), and Elfick (1979). A survey by Hermansen (1971) describes a fairly complete representation of an information system for regional development planning. The planning structure, shown in Figure 3, is a multidimensional, multilevel interactive representation of an integrated planning information system.

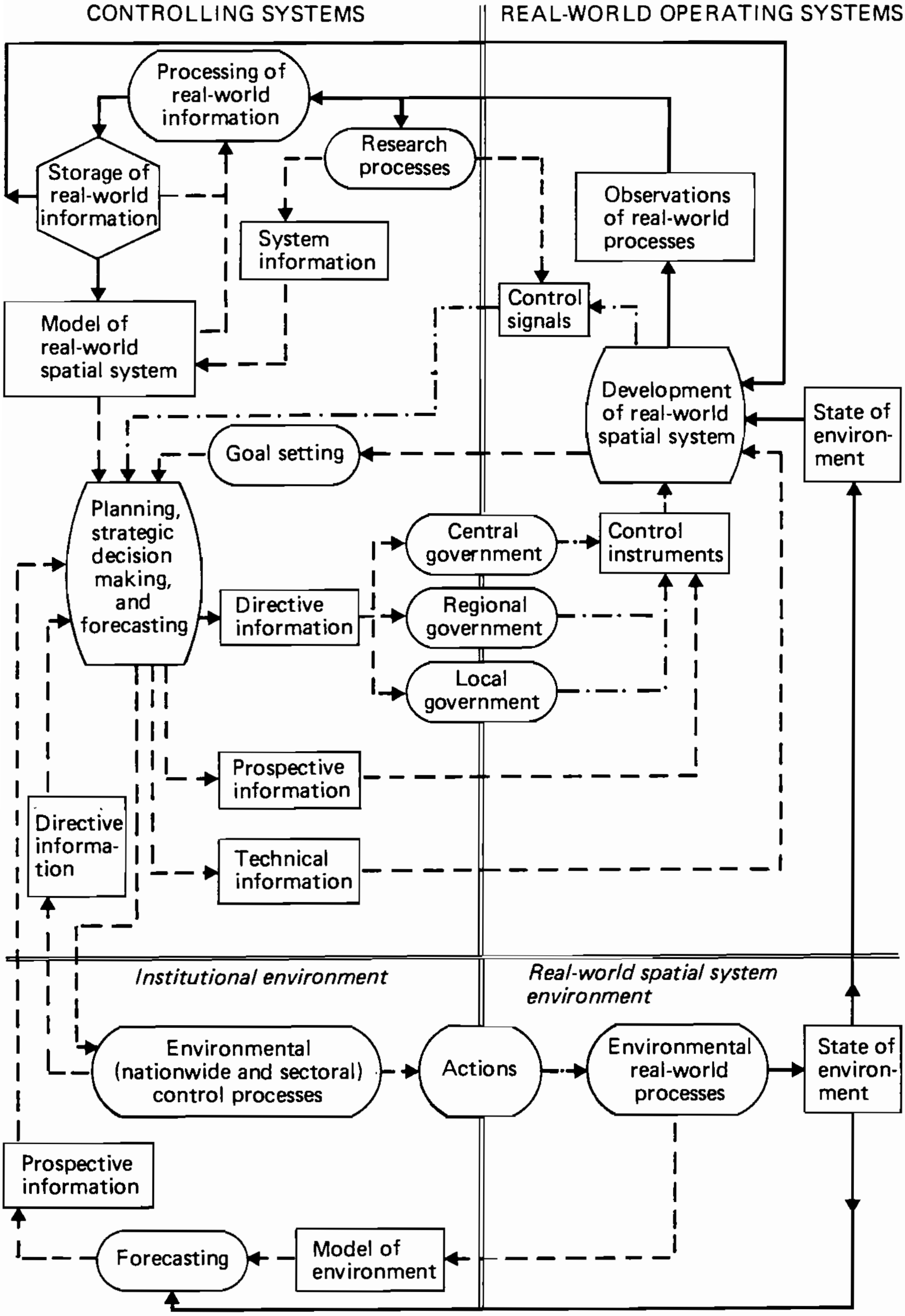

Figure 3 A comprehensive information system for regional development planning. Broken arrows (– – –), information flows; chain arrows (– · – ·), control signals; full arrows, relationships in the real world (source: Hermansen 1971, p.31).

4. The Spatial Scale in Information Systems

In many situations the necessary information on economic, industrial, ecological, agricultural, energy, or social aspects of a complex spatial system is not available on an appropriate temporal or spatial scale, although in this respect substantial progress is being made (see Chapters 15, 16 and Peters 1981). Clearly, information on the appropriate scale will aid analysis of a complex system.

As mentioned before, regional planning activities may take place at several levels, each activity influencing others. Figure 4 indicates that an integrated planning system may combine a bottom-up and a top-down structure. This structure may be analyzed by means of functional economic relationships (e.g. those included in a formal econometric model) while taking into account the prevailing institutional structure.

From an analytic point of view, *spatial demarcation* of a system (in terms of cities, regions, etc.) might be based on functional linkages between the spatial entities of the system, although lack of data very often hampers the application of this method of designing a spatial framework. From a planning point of view, spatial demarcation might be based on the existing administrative scheme, although here also data problems may emerge (Hermansen 1969). This problem has evoked the need for spatially disaggregated information systems (Chapter 15).

An interesting example of an integrated and spatially disaggregated information system can be found in Petzold and Heineke (1982), who designed a geographic information system for assisting soil scientists and hydrologists in ecological planning. Using thematic maps on various scales, they developed a computer-assisted geographic information system for storing and retrieving data at any desired spatial scale. The output could be produced on plotter-drawn maps, based on isolines, Thiessen polygons, and spline functions. Lacking data were generated by means of sampling points from a nonsystematic spatial distribution (using autoprojective, nonautoprojective, or autoprecessive methods).

Frequently, information systems for regional planning have been developed in close connection with multiregional models. Multiregional models, as an extension of traditional econometric modeling, are intended to yield consistent, coherent information to help identify the main driving forces and the mechanisms behind multiregional systems (Issaev *et al.* 1982). The aim for consistency and coherence will, in general, lead to a rejection of economic models that do not take into account the openness of a region. Thus, if interregional and national–regional links are not considered, there is no guarantee of consistency for the spatial system as a whole. Usually, there are various kinds of direct and indirect cross-regional linkages caused by spatiotemporal feedback and contiguity, so that regional developments may have nationwide effects. National or even international developments may also exert significant impacts on a spatial system; this is especially important because such developments may affect the competitive power of regions in a spatial system. For instance, a

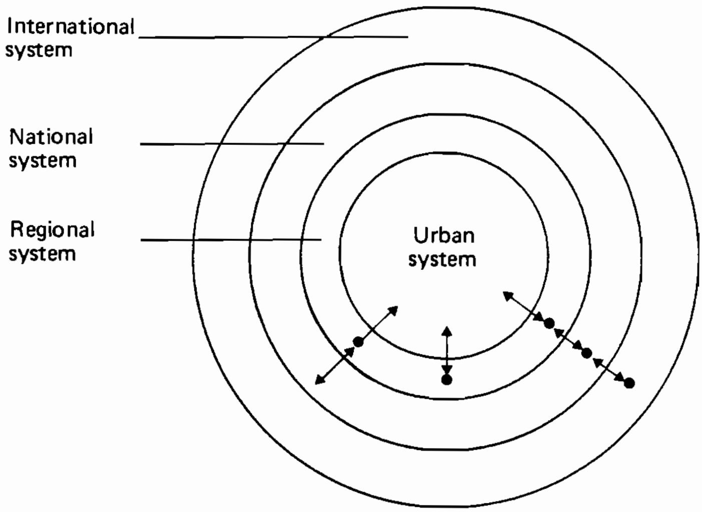

Figure 4 Illustration of various planning levels.

general national innovation policy may favor areas having large agglomerations. Because of the diversity of an open spatial economic system, planning activities need to be coordinated on the national and regional levels. Hence multiregional economic models are required in attempts to include regional profiles in national–regional development planning.

Let us now take a multiregional planning model focusing on one specific problem area (i.e. one specific profile) or on an integrated regional development pattern (including multiple profiles). We may then assume the following general framework for a multilevel information system, shown in Figure 5. The right-hand side of the figure represents the expected results in terms of the values of objectives, goal variables, and other relevant endogenous variables. In fact, two main questions may be studied by means of Figure 5:

- What is the optimum use of a *given* data input?
- What is the optimum data input to the information system for a *given* set of uses?

It is clear that the second question is the dual to the first. Also, the versatility of local data is much higher than that of regional or national data, since they can be used to build three types of systems model and to assess two different types of profile.

Furthermore, the output of this information system displays some interesting features. Local profiles can only be obtained by means of local data and a local model, whereas a national profile can be assessed in many ways, for instance by using local data in a multiregional model. All such combinations of ways of composing the relevant profiles should be studied carefully. However, not all data are necessarily observable at the most disaggregated (local) scale.

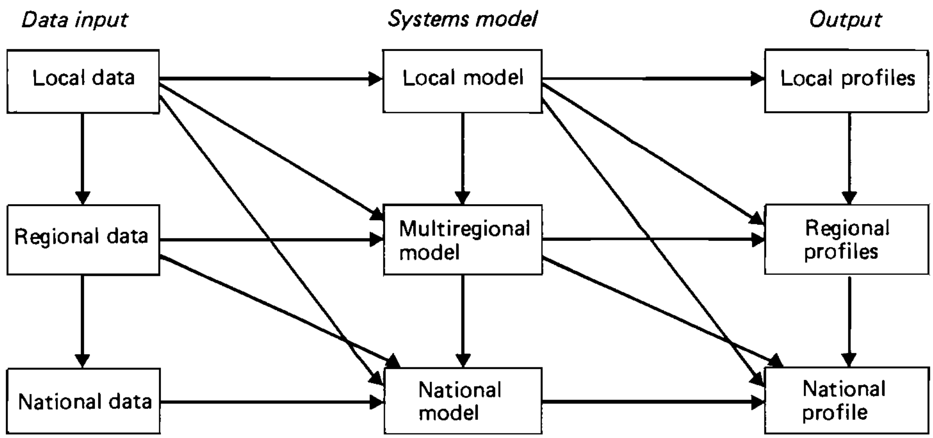

Figure 5 Structure of a multiurban, multiregional information system.

An associated problem is that of information loss caused by aggregating a system from a micro level to a meso or macro level, as the loss may occur in each of the three stages: data input, modeling, or production of final profiles. Similar problems may emerge in attempts to disaggregate existing data. These questions will be addressed more extensively in Chapter 13.

Finally, the related problem of adopting a bottom-up or a top-down approach may be eased by using information systems, not only from an institutional point of view but also from an analytic point of view (Nijkamp and Rietveld 1982).

5. Data Problems

Information systems for regional planning often suffer from a lack of reliable data, which significantly affects the authenticity of results from (multi)regional planning models. Unsatisfactory performance of regional models is often ascribed to a weak data base. Although unreliable data may affect the quality of the results, it is at the same time true that the structural and econometric aspects of many models presuppose a data base that is not really complete. Model users have to accept that there are inappropriate information systems and gaps in statistical data.

One way of compensating for lacking data is to incorporate qualitative data (Chapter 1), which are too often left out of consideration, although they may contain substantial information. Recent developments in qualitative (and fuzzy) spatial data analysis may help to extract as much as possible from all available relevant information, including the qualitative kind (Nijkamp *et. al.* 1983).

Examples of information that is often lacking in regional modeling are (Issaev *et al.* 1982):

Economic variables: stocks and flows of wealth, real and financial assets, and liabilities; scale and agglomeration advantages; capacity constraints; the value of public overhead capital; distributional effects.

Spatial variables: spatial interactions such as disaggregate migration and commodity flows; spatial spin-off and spillover patterns.

Process and state variables: technical progress, innovation, research and development, infrastructure, communication, energy productivity.

Sociopolitical variables: power groups, decision structures, interest groups, policy controls.

Basic variables: demographic structures, long-run regional dynamics.

Various spatial interaction models were developed in the 1970s to cope with the problem of limited spatial information (Smith and Slater 1981, Issaev and Umnov 1982). Solid model calibration is a necessity in the case of a weak data base.

In general, well ordered information systems are a prerequisite for the construction of appropriate regional models. Input–output matrices (especially of commodity-by-industry or rectangular form), capacity and bottleneck variables, social overhead capital, and interregional interactions are the basic ingredients of a satisfactory spatial information system. Absence of up-to-date information limits the ability of modelers to represent regional systems. The construction of input–output models based on very old data is not a satisfactory activity, although several models sometimes use 10- to 15-year-old data. Of course, data availability varies from country to country, and often within countries, but one of the crucial gaps is in information on regional stocks and interregional flows. Apart from measuring these factors, a major problem is that the responsibility for collecting and organizing data is sometimes shared by several offices, so that incomplete data bases may be created. Data bases sometimes include investment data for manufacturing, but very little else (except in some countries, such as Japan (Kitamura 1982)). This situation is regrettable, especially as movements of capital are very important in long-term regional developments in market economies.

A similar situation exists for interregional monetary flows (social insurances, old-age pensions, entrepreneurial profits, etc.). These flows have a direct, distributive impact on a system of regions, but they are neglected in many regional models.

It is not the intention here to design an information system that satisfies all the conditions mentioned above, but it is a useful exercise to analyze existing spatial information systems in their geographic, socioeconomic, and institutional contexts. Therefore, the present study aims to produce:

- a general evaluation of international experiences regarding the association of information systems with (multi)regional planning;
- an inventory of recent trends in designing operational regional and multiregional information systems; and
- an assessment of the prospects of spatially oriented information systems designed for regional and multiregional planning.

These aspects will be explored in subsequent chapters. Reference may also be made to Henrichsen and Wagtskjold (1982), who discuss the design of a joint European data base.

Apart from data problems as such, the use of data in an integrated spatial system has to be discussed. The integrated system represented in Figure 6 deals with a multicomponent structure for regional impact analysis. Regional information systems normally have to provide assessments of the expected consequences of alternative policy measures. Various questions have then to be addressed in order to build up an efficient information system for regional planning:

- What are the relevant variables for the profiles?
- What is the best model specification for the particular purpose?
- Which data are needed to estimate the model?
- Which kinds of impact analysis and evaluation analysis are the most appropriate for the particular purpose?
- What is the best way of storing and updating this information in order to fulfill the criteria for information systems mentioned in Section 3?

All these questions imply certain trade-offs, for instance between the expected benefits of an information system and the costs of data collection and storage, or between the expected benefits of an information system and the costs of building a model (Figure 7).

Therefore, building an information system involves a compromise between conflicting criteria. At present, systems of information (statistics and specialized operative systems) are incomplete, inconsistent, and insufficiently oriented for an analysis of geographic aspects of socioeconomic development planning. The results are a lack of data for models, inadequate use of information for the decision-making process, and difficulties faced by users in making consistent decisions and in implementing models. How can the needs for information for planning integrated regional–national developments be fulfilled? The development of computerized information systems supporting regional and national planning and management has been marked by much progress in recent years and has led to a variety of valuable experiences, the accumulation of which could greatly contribute to the solution of this problem. Therefore,

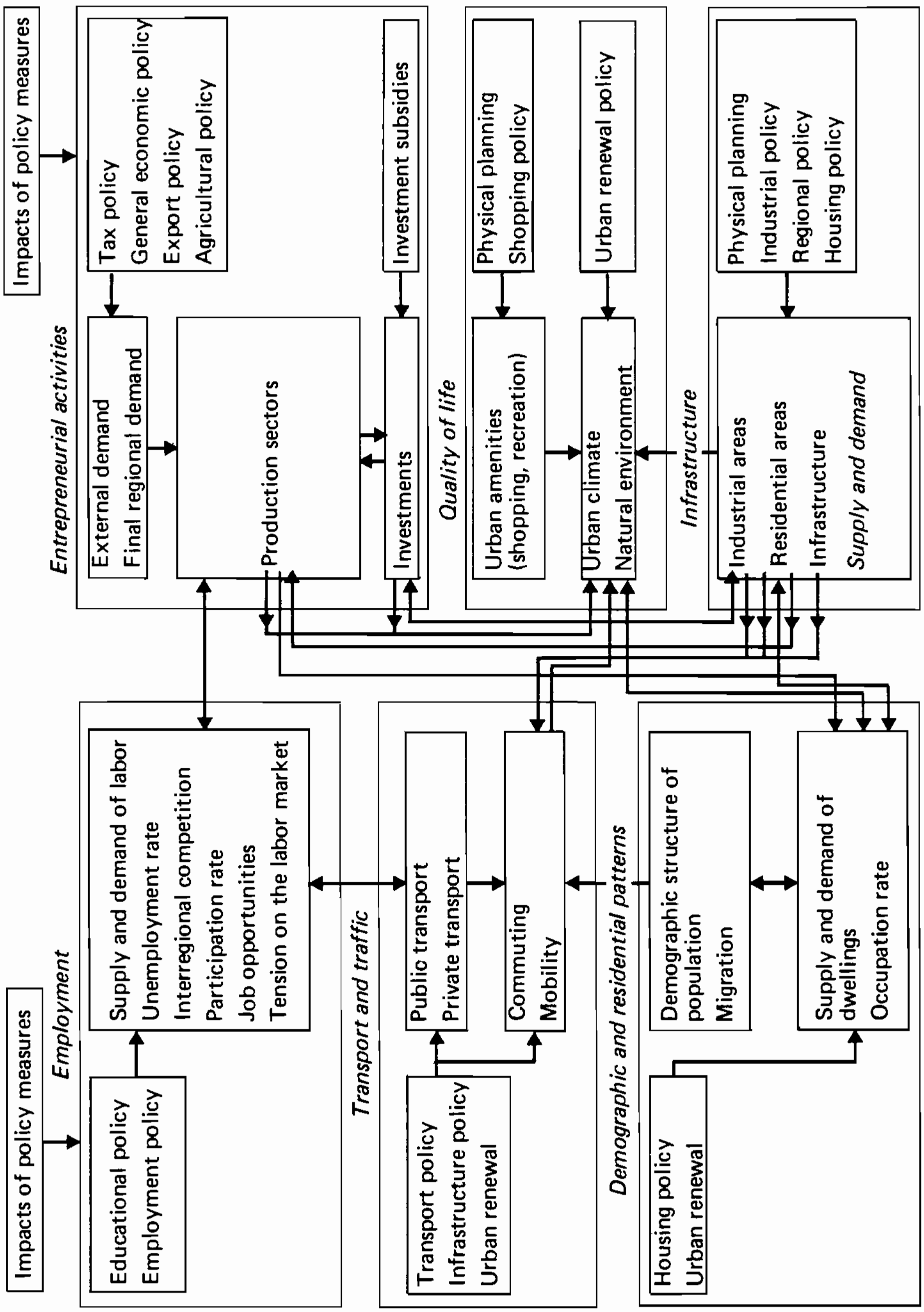

Figure 6 An integrated spatial system (source: Nijkamp 1981).

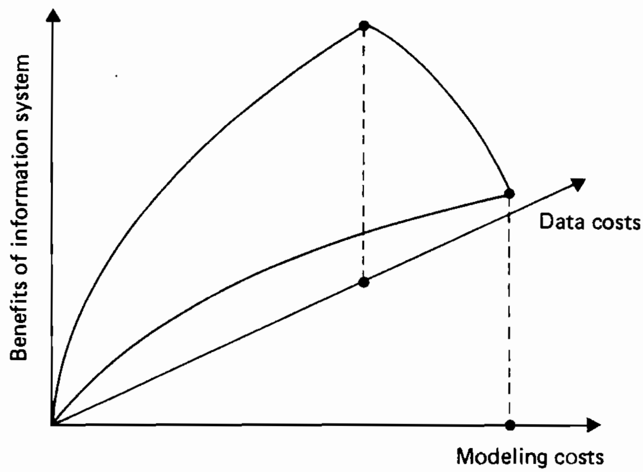

Figure 7 Trade-offs between benefits and costs.

a rigorous endeavor has to be made to develop a coherent and systematic framework for effectively using spatially oriented information systems in regional planning. The last section of the chapter will take up this issue further.

6. Regional Planning and Information Systems

The increased demand for regional statistics is shown by the large number of agencies involved in the production of data series. Unfortunately, many data are not comparable between series because, apart from statistical and measurement reasons, each administrative body has an interest in particular data (Garnick 1980). Theoretically, spatially oriented information systems should be developed from decision theory as applied to regional systems, in which goals, tools, actors, and institutional management patterns are integrated (Chapter 1). In practice, however, information systems and planning systems have been developed relatively independently. Coevolution of both kinds of systems would require an adaptation of information systems to regional planning issues and an adaptation of planning systems to available spatial information, but in short-term and often *ad hoc* planning such coevolution is difficult (Schmitt 1980).

In the long term more possibilities for integration of information and planning systems do exist. Issaev (1982b) indicates that in long-term planning of regional development two issues are crucial: (a) long-term structural adaptation of the region to external changes, and (b) reconciliation of regional–national conflicts by integrating sectoral and regional approaches to national planning. Within the national system, the region operates through mechanisms of homeostasis. But how does this function? And who supports regional interests at the national level? What is the system of values through which economic agents perceive and respond to changes? What are the laws governing their behavior? Such questions are fundamentally important in long-term planning, which requires information on all elements of a regional system, their dynamic properties, and their mutual links. In addition, data are needed on elementary spatial units within which decision making is based on specific interests and behavioral rules. Even though macroregional information may exist in statistical and specialized agencies, its micro or meso components (Perrin 1975) can only be partially covered by local administrative information systems. The whole area of social behavior, which finally determines the system of social values, is not adequately covered by regular information. Much of the research into developing regional information systems is directed toward filling this gap, but its success is certainly not overwhelming.

On the other hand, some countries (e.g. Sweden and the USSR) have succeeded in designing integrated information systems for regional planning. For instance, the USSR has programmed and designed a state automated information system for planning and managing the economy of the USSR. This information system, named OGAS, is a computerized information system, in which data are stored and processed in a network of computing centers accessed by telecommunications lines. The regional dimensions of this system are covered by territorially based subsystems that store and monitor information on socioeconomic relations and activities as well. Such spatially oriented information systems include data on natural resources, population, labor markets, technology, settlement patterns, investments, production, environmental quality, and living standards. Needless to say, monitoring of such complex structures is a far from easy task.

Monitoring regional plans is, however, a logical consequence of advocating a procedural model of regional planning (Faludi 1973). A comparison of monitoring systems should, therefore, take into account the differences in underlying planning systems and processes (Masser 1981). Monitoring systems may also play a crucial role in strategic decision making. A thorough analysis of such information and monitoring systems in the framework of strategic urban and regional decision making can be found in Scheele (1983). In general, the major shortcomings of current information systems for regional planning appear to be the lack of user-friendliness, the impossibility of taking into account dynamic structural changes, the lack of coherence and reliability, and the lack of orientation toward a specific planning style or a specific institutional setting.

There is evidently no uniform and unambiguous definition of a spatially oriented information system for regional planning, though its aims and contents in a specific context can be delineated. It may be possible, however, to indicate some general features and components of a spatial

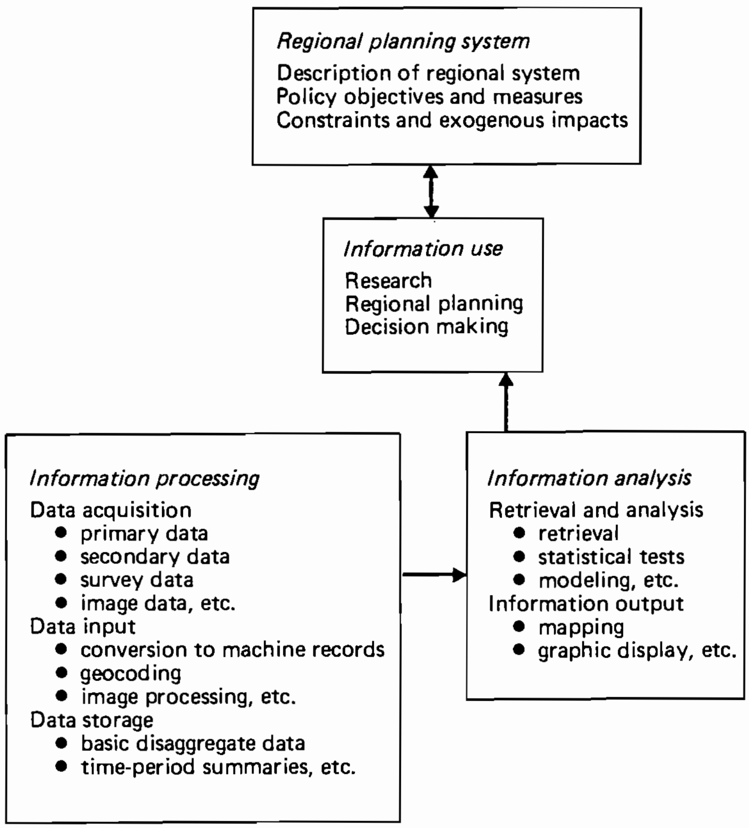

Figure 8 A spatially oriented information system for regional planning.

information system. According to the Commission on Geographical Data Sensing and Processing of the International Geographical Union (1980), an "ideal" geographic system comprises six major subsystems:

(1) Management
(2) Data acquisition
(3) Data input and storage (control processes, encoding, filing, etc.)
(4) Data retrieval and analysis (data comparison, statistical operations, etc.)
(5) Information output
(6) Information use (e.g. interface between user and system).

This analysis gives rise to the simplified structure in Figure 8, which shows the major components. Other important features, such as spillover effects and multilevel patterns, have been neglected. Several of these features will be discussed in subsequent chapters.

References

Baranov, E.F., and I.S. Matlin (1982) A system of models for coordinating sectoral and regional development plans. *Multiregional Economic Modeling: Practice and Prospect*, eds. B. Issaev *et al.* (Amsterdam: North-Holland), pp. 143–155.

Barraclough, R.E. (1964) Geographic aspects of information retrieval. *Paper* presented at 2nd Annual Meeting of Urban Planning Information System Conference, University of Pittsburgh, Pittsburgh, PA, September.

Benjamin, B. (1976) *Statistics and Research in Urban Administration and Development* (The Hague: International Association for Regional and Urban Statistics).

Blumenthal, S.C. (1969) *Management Information Systems* (Englewood Cliffs, NJ: Prentice-Hall).

Bowman, C.T., and R.E. Kutscher (1980) The labor market data base for multiregional models. *Modeling the Multiregional Economic System*, eds. F.G. Adams and N.J. Glickman (Lexington, MA: Heath), pp. 57–64.

Commission on Geographical Data Sensing and Processing of the International Geographical Union (1980) *Computer Software for Spatial Data Handling* (Ottawa: IGU), 3 vols.

Elfick, M. (ed.) (1979) *URPIS Seven* (Melbourne: Australian Urban and Regional Information Systems Association).

Faludi, A. (1973) *Planning Theory* (Oxford: Pergamon).

Garnick, D.H. (1980) The regional statistics system. *Modeling the Multiregional Economic System*, eds. F.G. Adams and N.J. Glickman (Lexington, MA: Heath), pp. 25–48.

Grimmeau, J.P. (1981) An automatic method of data simplification for area mapping. *European Progress in Spatial Analysis*, ed. R.J. Bennett (London: Pion), pp. 290–296.

Guesnier, B. (1978) Le système d'information régional. *Report*, University of Poitiers, Institute of Regional Economics.

Hagerstrand, T., and A.R. Kuklinski (eds.) (1971) *Information Systems for Regional Development* (Lund, Sweden: University of Lund).

Henrichsen, B., and J. Wagtskjold (1982) Building a joint European data base for regional time series. *Applied Urban Research*, eds. G.-M. Hellstern, F. Spreer, and H. Wollmann (Berlin: Social Science Research Center, Free University), pp. 147–162.

Hermansen, T. (1969) Requirements and provision of information for regional development planning in Sweden. *Report*, United Nations Research Institute for Social Development, Geneva.

Hermansen, T. (1971) Information systems for regional development planning. *Information Systems for Regional Development*, eds. T. Hagerstrand and A.R. Kuklinski (Lund, Sweden: University of Lund), pp. 1–37.

Issaev, B. (1982a) Multiregional economic models in different planning and management systems. *Multiregional Economic Modeling: Practice and Prospect*, eds. B. Issaev *et al.* (Amsterdam: North-Holland), pp. 83–95.

Issaev, B. (1982b) Information for long-term planning of regional development *Paper* presented at 22nd European Congress of Regional Science Association, Groningen, 24–27 August.

Issaev, B., P. Nijkamp, P. Rietveld, and F. Snickars (eds.) (1982) *Multiregional Economic Modeling: Practice and Prospect* (Amsterdam: North-Holland).

Issaev, B., and A. Umnov (1982) Integrated economic balance of a regional system. *Working Paper* WP-82-118, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Kitamura, T. (1982) An agricultural model in the regional framework (a methodological case study in Japan). *Interim Report*, Food and Agriculture Program, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Kuklinski, A.R., (ed.) (1974) *Regional Information and Regional Planning* (The Hague: Mouton).

Masser, I. (1981) The analysis of planning processes: A framework for comparative research. *Report*, Department of Town and Regional Planning, University of Sheffield, UK.

Nijkamp, P. (1981) Urban impact analysis in a spatial context. *Research Memorandum* 1981-5, Department of Economics, Free University, Amsterdam.

Nijkamp, P., H. Leitner, and N. Wrigley (eds.) (1983) *Measuring the Unmeasurable: Analysis of Qualitative Spatial Data* (The Hague: Martinus Nijhoff).

Nijkamp, P., and P. Rietveld (eds.) (1981) *Cities in Transition* (The Hague; Boston, MA: Martinus Nijhoff).

Nijkamp, P., and P. Rietveld (1982) Structure analysis of spatial systems. *Multiregional Economic Modeling: Practice and Prospect*, eds. B. Issaev *et al.* (Amsterdam: North-Holland), pp. 35–48.

Perrin, J.C. (1975) *Le Développement Régional* (Paris: Presses Universitaires de France).

Peters, A. (1981) Die Verstätterung in den Niederlanden nach 1950 und seine Raumordnungspolitischen Implikationen. *Ph.D. Thesis*, Technical University, Berlin (West).

Petzold, E., and H.J. Heineke (1982) Geographic information systems. *Report*, Institute of Geography, Westfalian Wilhelms University, Münster, FRG.

Scheele, R.J. (1983) Making plans work. *Ph.D. Dissertation*, State University, Utrecht.

Schmitt, R.R. (ed.) (1980) *Ends and Means in Urban and Regional Information Systems: Bridging the Gap in the 1980s*. Papers of Annual Conference of Urban and Regional Information Systems Association, Toronto, 17–21 August.

Sibert, J.L. (1980) Continuous-color choropleth maps. *Geo-processing* **1**(3): 207–216.

Smith, T.R. and P.B. Slater (1981) A family of spatial interaction models incorporating information flows and choice set constraints applied to US interstate labor flows. *International Regional Science Review* 6 (1): 15–31.

Steiner, D. (1980) A minicomputer-based geographical data planning system. *Map Data Processing*, eds. C.H. Freeman and G. Pieroni (New York, NY: Academic Press), pp. 1–25.

Thelander, H. (1981) Experience with the Swedish Regional Statistic Data Base. *Report*, National Central Bureau of Statistics, Stockholm.

Tobler, W.R. (1979) A transformational view of cartography. *The American Cartographer* 6(2): 101–106.

Torene, R., and D. Goettee (1980) Towards a general purpose economic data base. *Modeling the Multiregional Economic System*, eds. F.G. Adams and N.J. Glickman (Lexington, MA: Heath), pp. 65–72.

Willis, J. (1972) Design issues for urban and regional information systems. *Working Paper* 71, Centre for Environmental Studies, London.

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CHAPTER 3

Political, Social, and Technical Bottlenecks in Computerized Spatial Information Systems

Aribert B. Peters

1. Introduction

In the 1960s and early seventies computers of high speed and large storage capacity became generally available and were rapidly adopted by big firms and administrations. The expected breakthrough of computers and quantitative models into planning, especially regional planning, did not occur, however. Even today, computers are not used at all in most planning applications. This is astonishing because a broad variety of facts have to be assembled in a plan, and data retrieval and preparation, exactly the type of work that is efficiently performed by computer, are thus very important.

This chapter will investigate which organizational and technical factors have inhibited the general use of computerized information systems. It will be argued that the political nature and the irrational features of planning have to be respected in the design and implementation of information systems. These aspects, together with improved technology, favor small-scale regional information systems. The term "information system" in this chapter refers to a data base and its use for planning purposes.

Computers are adopted most rapidly for applications with highly standardized working patterns. In contrast, spatial planning is in many respects routinely unique and novel. Therefore, the ease with which computerized information systems can be introduced depends crucially on how they are implemented and on the adaptability of such systems to different needs and tasks. The gain in efficiency must exceed the human and organizational inertia that tends to damp out the intended benefits of innovation.

2. The Unavoidable Complexity of Spatial Information Systems

Spatial information systems differ from other kinds of information systems in several ways. Firstly, space as an additional dimension increases the amount of relevant data by a multiple of the number of spatial units. This may raise problems of storage capacity and computing time and costs. To solve these problems the software has to be improved. Moreover, in order to make analytic use of the spatial properties of data for planning it is necessary to connect the relative positions of each spatial unit (Weber 1979). This complicates the process of creating models and theories, as well as the data storage and referencing system.

Other problems arise both in spatial and nonspatial information systems but are more critical for spatial systems. (a) The spatial scale determines the size and also the possible uses of the system. (b) In almost every practical application the definition of the spatial units is altered over time because of changes in administrative boundaries. (c) Data are not measured in the same way for every spatial unit or every point in time. However, the procedures for making the necessary *ad hoc* corrections are hard to standardize. (d) Flexibility presupposes the possibility of looking at already available data in different ways. The higher the degree of aggregation of the stored data, the harder it is to introduce new criteria for aggregation. To have a flexible system requires that the most disaggregated data are stored. Flexible data evaluations thus cause overloaded, inflexible technical storage procedures. For these reasons spatial information systems are much more expensive than their nonspatial counterparts.

So far we have concentrated on the data base of the information system, but most of the arguments can be applied to other components of the system, such as the communication language, which needs to be more refined when reference to space or cartographic output is introduced. Also, spatial models are much more complicated than nonspatial ones.

The size of the information system is of critical importance for its efficiency. The size depends on the area covered by the system, the degree of spatial detail (the scale), the number of aspects included in the system, and the degree of spatial referencing (spatial connectivity of the data). Each of these determinants depends on the organizational framework in which the system is developed.

3. Information and Power: Data as Political Resource

The control of information is a key source of the ability of the planner to exert influence (Forrester 1982, p.68). One reason for this is that information supplies solutions to technical problems (e.g. in civil engineering). Some people see only this technical aspect of information. They overlook the political judgments involved and the political environment of planning organizations.

Information is a source of power because it responds to organizational needs. People need to know who to go to for information, and how to have a project approved, for example. Informal communication networks and steady contacts keep the planner "in the know." Information can also be used to legitimize or rationalize the maintenance of existing structures of power, control, and ownership.

Finally, information can be used by underrepresented or relatively unorganized groups to enable them to participate more effectively in the planning process.

In a dialectic sense the lack of information and misinformation are necessary counterparts to information as power. The exchange of information is therefore less a technical problem than a political problem of power distribution. The confidentiality argument is often used to justify the parsimony of information monopolists to obscure their true motivations. Sharing power by means of shared information is as important in the bargaining process between the public and the administration as between different administrations or even within one administration. This explains why comprehensive spatial data banks are difficult to establish through the exchange of information among different administrations.

The very nature of information systems requires that people or organizations give away their private information to the system, which implies that they might give away their power to take part in bargaining processes and to influence decisions. It would be hard to convince people about the advantages of such an information system without giving them any formal or informal guarantee that they would also benefit from the system. This requires that each participant takes part in the design of the system, thus ensuring his influence; knows how to manipulate the information system; gains power because he can use his own data more effectively with the help of other data; and is allowed to control the information that he brought into the system.

Since all these requirements are hard to fulfill, a comprehensive spatial information system is difficult to establish, even if technical problems are not considered. If such a "supersystem" were possible, its information would be difficult to control and to monopolize. With individuals as its basic units, the system would present an opportunity for "Big Brother" power and control over all individual actions. This explains much of the resistance against supersystems on the part of emancipated citizens and parliamentarians.

To avoid resistance and to ensure that data are contemporary, a sampling approach can be followed. Microcensuses are conducted at short intervals in most countries anyway. They can be used to update census data at a regional level with appropriate techniques. The microcensus information might be further improved if the samples are thoughtfully drawn and panel techniques are used.

Because planning as a comprehensive task comes into conflict with each planning area (traffic, construction, etc.) and because planning takes place at different spatial levels, often in an inconsistent way, the problem of administrative competence gains relevance in the design of a spatial information system. A common information base would be a step toward consistency and will therefore conflict with the claims for responsibility of different parties involved in planning. Many agents and units in organizations obtain influence and autonomy from their control over information, and will not readily give it up. In many instances new information systems represent a direct threat, and they respond accordingly.

4. The Limited Relevance of Information in Decision Processes

As a corollary, formalized information systems are often threatening and unnecessary. They are an intrusion into the world of the users, who see these unfamiliar techniques as irrelevant and a criticism of themselves. Almost every descriptive study of a complex decision process suggests that formal analysis of quantified information is, at best, a minor aspect (Keen 1981). Negotiations, habit, rules of thumb, and muddling through (Lindblom 1959) have far more force. The point is not that managers and planners are stupid or information systems irrelevant but that decision making is multifaceted, emotive, conservative, and only partially cognitive.

Formalized information technologies are not as self-evidently beneficial as technicians presume. Simon's (1957) concept of bounded rationality stresses the simplicity and limitations of individual information processing. Not the supply but the evaluation of information is the critical bottleneck in the planning process (Ganser 1974, p. 214).

5. Implementation Strategies

All existing experience shows that it is of major relevance for the use and the success of a system that the users have taken part in its creation. A so-called participative or consensus system design (Mumford 1979) is a precondition for a system that is shaped after the users' needs in the design phase and that is generally used after its implementation.

Implementation *is* possible but it requires patience and a strategy that recognizes that the process of change must be explicitly managed (Keen 1981). Keen developed a tactical model for successful implementers:

(a) Make sure you have a contract for change.
(b) Seek out resistance and treat it as a signal to be responded to.
(c) Rely on face-to-face contacts.
(d) Become an insider and work hard to build a personal credibility.
(e) Co-opt users early.

Bardach describes implementation in terms of a game played by the implementer's party against the counterimplementers (Bardach 1977, Keen 1981). For practical tasks it might be essential to identify the moves of the counterimplementers:

(a) Lay low.
(b) Rely on inertia.
(c) Keep the project complex, hard to coordinate, and vaguely defined.
(d) Minimize the implementers' legitimacy and influence.
(e) Exploit their lack of inside knowledge.

6. Regional Information Systems in Practice

As a matter of fact many urban and regional information systems have functioned quite well for a long time. They are operating more as data bank systems than as planning devices. Their analytic capacity in most cases does not exceed cross-tabulations. They are used by planners in a similar way as are statistical publications. Examples are the highly developed information systems at the author's own institute and at different regional statistical offices in the Federal Republic of Germany. Such experiences are reported in most western countries. Integration is only performed through providing information about different subjects. In the same large computers it is often also possible to run models and to draw maps. More relevant for physical planning are automatic registers of assessments that are developing in several cities.

Most of the mentioned projects are based at mainframes, i.e. on very large and expensive computers. The manpower requirements are of comparable size, so that only statistical offices and large nationwide planning institutions with their own computer departments could establish such systems (Wegener 1978). Furthermore, a large number of small-scale projects and local agencies have set up their own data bases. A further major increase of such systems can be expected in the next few years (PArC 1979, Urban Data Management 1979, Lewis 1982).

7. Concluding Remarks

Planning is a political process because it is directed by the desires, perceptions, and values of people and because the implementation of plans is a political process. The use of computers and of rational models does not necessarily increase the rationality of the planning process. Only if the political nature and the irrational aspects of planning are reflected in the design of systems (i.e. language, data, structures, etc.), as well as in the circumstances of their implementation, will integrated information systems be of use in the future. There is little hope and little need to integrate urban, regional, and national planning information systems because of different problems, models, data requirements, organizations, and institutional responsibilities.

The decrease of hardware prices has made powerful computers available to smaller offices. The obstacles to comprehensive systems will favor the use of small systems and lead to an atomistic spread of simple, special-purpose information systems providing considerable technical support to planners at different levels. Improved technology will also partly resolve the trade-off between flexibility on the one hand and simplicity of use in spatial information systems on the other hand.

References

Bardach, E. (1977) *The Implementation Game: What Happens After a Bill Becomes a Law*? (Cambridge, MA: MIT Press).

Forrester, J. (1982) Planning in the face of power. *Journal of the American Planning Association* 48: 67–80.

Ganser, K. (1974) Einführung. *Informationen zur Raumentwicklung* 6:213–216.

Keen, P.G.W. (1981) Information systems and organizational change. *Communications of the ACM* 24: 24–33.

Lewis, S. (1982) The modern planning office. *Planning* 48: 12–20.

Lindblom, C.E. (1959) The science of muddling through. *Public Administration Review* 19: 79–88.

Mumford, E. (1979) Consensus systems design: An evaluation of this approach. *Design and Implementation of Computer-Based Information Systems*, eds. N. Szyperski and E. Crochla (Alphen aan de Rijn, Netherlands: Sijthoff and Noordhoff), pp. 221–230.

PArC (1979) Internationaler Kongress über den Einsatz von Computern in Architektur, Bauwesen, und Stadtplanung. *Summary of Conference Papers*, Berlin (West)(On-line Conferences Ltd.).

Simon, H.A. (ed.) (1957) A behavioral model of rational choice. *Models of Man* (New York, NY: Wiley), pp. 241–260.

Urban Data Management (1979) *Proceedings* of 7th European Symposium, The Hague.

Weber, W. (1979) Geographic information systems. *Jahrbuch für Kartographie* 19: 110–138.

Wegener, M. (1978) The impact of systems analysis on urban planning: The West German experience. *Systems Analysis in Urban Policy Making and Planning*, eds. M. Batty and B. Hutchinson (London: Plenum).

PART

B

Types and Uses of Information Systems

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CHAPTER 4

Information for Long-Term Planning of Regional Development

Peter W.J. Batey

1. Introduction

Compared with other fields of public administration, regional planning stands out in its attempts to relate policies and proposals to a long time horizon. Whereas in most fields seven or eight years may be regarded as long-term and an upper limit on the period to which consideration should be given, in regional planning it is likely that such a period would be viewed as medium-term. The periods adopted for regional planning purposes are broadly 0–5 years as short-term, 5–10 years as medium-term, and 10–20 years as long-term.* This longer policy time scale reflects certain features of the processes of change in which regional planning seeks to intervene: the long lead times for development projects, the long life of infrastructure (particularly housing, industrial, commercial, and educational facilities, and highways) and the long-term benefits sometimes associated with these development projects.

The purpose of this chapter is to provide a survey of the range of information that is required to support the long-term strategic planning of regional development. We begin by examining some of the principal characteristics of the regional planning process and show how this process influences the need for information. We argue that the vast majority of information requirements stem from the desire, widely expressed by regional planners, to make this process *systematic*, *comprehensive*, and *continuous*. Using six varied examples of the application of information systems in long-term regional planning, we try to emphasize the particular contribution that each information system can make to the regional

* This in itself is a shortening of time scales that were used in several of the early regional planning exercises. In British advisory regional plans of the 1940s it was not unusual to set the time horizon at thirty or forty years.

planning process – in setting the context for intraregional planning, in analyzing specific topics such as transport, the local economy, or population, in integrating partial analyses, in generating and evaluating alternative strategies, and, finally, in gauging the impact, upon existing policies as well as the study region itself, of major development proposals. The examples are drawn from a number of different countries and deal with qualitative as well as quantitative information.

2. The Information Requirements of Regional Planning

Regional planning is no exception to the general movement in public policy making during the last twenty years toward greater rationality. The loosely related combination of survey, analysis, and plan, which exerted a strong influence on planning for more than half a century, has given way to a more systematic and explicit process based on rational decision theory. The most important elements of this process are an explicit statement of planning objectives or problems, the generation, elaboration, and evaluation of alternative packages of policies designed to meet these objectives, and the choice of a preferred set of policies. Policy making usually proceeds in a series of cycles, each cycle including some or all of the stages in the process, and the planner is expected to learn as he moves from one cycle to the next. The policies that emerge are not to be seen as static, but are expected to be updated by continuous monitoring and review.

British development plans of the last ten years provide a good example of an attempt to introduce a regional planning process embodying these features. In the late 1960s a two-tier system of planning came into effect, with upper-tier, strategic or "structure" plans intended to provide a broad and integrated policy framework, in the form of a written statement of policies and proposals for the future development of a region* over a ten- to fifteen-year period. Detailed, map-based planning would be the subject of lower-tier, local plans set within the policy framework.

The information requirements of a planning process of this kind are a product of the efforts to make regional planning systematic, comprehensive, and continuous. In the case of structure plans, policies and proposals had to be supported by analysis and reasoned justification: the need for a particular policy or proposal had to be shown in relation to the aims of the plan, to explicit assumptions about underlying social and economic factors influencing development, and to the likely availability of financial resources. It was expected that each topic covered by the plan would be the subject of a detailed internal analysis, including some consideration of past trends, the present relationship between supply and demand, and an

* Here "region" is equated with "county," since 1974 the upper-tier administrative unit of local government in England and Wales.

attempt to forecast future activity levels (Department of the Environment 1970). The integration of analysis across several topics was also felt to be an important means of achieving consistency among policies and activity forecasts, although, as Barras and Broadbent (1982) found in a review of twenty structure plans, in practice the analysis of these linkages is seldom more than cursory.

The strong tradition of comprehensiveness in regional planning is reflected both in the range of topics addressed by the plan and in the variety of agencies expected to play a part in implementing the policies and proposals that it contains. Typically the scope of the plan would include population, housing, the economy, services, transport, and the environment, with other topics added where they are felt to be of local significance. In structure planning, the depth of treatment of each topic has been the subject of some debate. Initial attempts to cover all topics in a similar degree of detail have proved to be overambitious, in terms of staff time and data availability, and more recently it has become almost standard practice to adopt an approach focusing upon selected topics with major implications for policy or for short-term investment programs.* Minor topics, of secondary importance, would be pursued in later cycles of policy making (Drake *et al.* 1975).

The policies in the plan can be expected to cover the relevant activities of all agencies in the region, including private companies, nationalized industries, central government, and households, as well as those of the regional authority itself. Because many of these agencies will themselves be involved in strategic planning or strongly affected by its results, it is vital that those engaged in preparing and implementing the regional plan maintain a close dialogue with these agencies. In any case, the implementation of regional planning policies by other agencies will usually depend more on mutual trust, bargaining, and persuasion than on coercion and legal controls. Inevitably this means that there should be a steady flow of policy-related information between the various bodies involved in planning.

The third requirement for information arises from attempts to establish a continuous regional planning process based on monitoring. The activity of monitoring – the regular, deliberate, and systematic collection and analysis of information (McLoughlin 1975) – is sometimes interpreted in rather narrow terms as the detection of departures from the planned course of development. Such a view ignores the enormous amount of uncertainty associated with regional planning policies and tends to suggest that the "planned course of development" is something that is fixed and completely understood. A second, more broadly based approach concentrates on three main themes: targets (are policies effective in achieving objectives?); achievements (have policies resulted in unintended consequences?); and assumptions (are the underlying assumptions and objectives of current policies still relevant?).

* In Britain these programs would include transport and housing investment.

This last theme, the monitoring of assumptions, reflects the fact that, with the passage of time, policies can be expected to "decay" until they are no longer appropriate and must be either modified or replaced (Thorburn 1975, Parker 1978). The decay of policy is likely to be the result of changes in value systems (and therefore in priorities, e.g. as a result of a change in political administration), changes in the external environment (e.g. a major shift in a basic assumption such as the rate of economic or demographic growth), and changes in the policies being pursued by other planning bodies (e.g. central government or another local authority). The role of monitoring in this case is to harness information to reduce uncertainty about these changes so that obsolete policies can be quickly identified and discarded.

The information base required to reduce uncertainty includes both qualitative and quantitative components. Describing the Hampshire structure plan monitoring system in Southeast England, Francis (1981) makes a further distinction between hard and soft qualitative information. Hard verbal information might include information on policies approved, commitments made, and events that have occurred, while soft information would embrace information on emerging policies, proposals under consideration, assessments of a problem, and public attitudes toward certain issues.* Information of this kind can be acquired from a wide variety of sources, such as published reports, internal papers, the press, personal contacts, and committee members. Francis (1981, p.183) points out that the organization and retrieval of qualitative information can be very time-consuming and much more difficult than for quantitative information.

Quantitative information has tended to attract greater attention and a substantial literature has developed over the last ten years, dealing with data capture, organization, and linkage (e.g. Willis 1972, 1974). In a monitoring context, its main purpose is to enable selected trends to be established, to facilitate the linkage of data, and to allow sets of forecasts and projections to be revised. Among practitioners, however, there is some scepticism about the feasibility of measuring the performance of planning policies by defining a set of standard quantitative indicators (Parker 1978), because of the difficulties of isolating the effects of policy from other influences beyond the planner's control.

In the next section, we move on to consider specific applications of information systems in the long-term planning of regional development. Drawing on examples from Britain, the Federal Republic of Germany, the United States, and Australia, we demonstrate the broad range of information systems available and the stages in the regional planning process to which these systems can most usefully contribute.

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* Francis uses the term "soft information" to denote subjective information based on professional judgments and lay opinion. A different interpretation can be found in the econometrics literature, where soft information relates to ordinal, categorical, nominal, or fuzzy information (Nijkamp and Rietveld 1982).

3. Information Systems and the Long-Term Planning of Regional Development

3.1. *Scenarios and the Structuring of Qualitative Information*

An important element in the qualitative information base of regional planning involves making a series of assumptions about the impact upon regional development of broad economic, social, and technological trends that are generally beyond the control of the regional plan. Although these trends may be a reflection of national and world-scale developments, they will nevertheless have direct implications for the population, economy, and physical environment of the region being planned. The great variety of possible outcomes of such trends makes the production of regional activity forecasts extremely hazardous and rules out the use of a single, best-estimate projection upon which regional planning policies can be based. An alternative approach to managing this uncertainty is to focus upon scenarios, which combine a group of related changes and possible responses so as to allow comparison of their different implications for the long-term planning context (Thoenes 1977). Scenarios will help to establish the range of possible futures with which a plan might need to contend. Thus proposals and policies can be formulated in such a way that they could be adjusted or amended to take account of changing circumstances within this range.

The scenario approach has been adopted in South Hampshire, generally regarded as one of the growth areas in Southeast England (Linecar *et al.* 1981). Here the central concern was to establish possible courses of change in South Hampshire and to consider how these would influence land requirements over a fifteen-year period. Time and manpower restricted the study to the use of secondary sources – studies and reports by researchers and futurists, supplemented in some instances by published statistics to establish the present situation and immediate past trends. It was evident that to concentrate on regional trends would be both difficult, because of a shortage of relevant information, and unrealistic, because in the long term regional trends would be affected as much by national trends as by local factors. Similarly, national trends cannot be seen in isolation from world events, particularly in view of the vulnerability of national economies to international trade and politics. It was also felt that many of the future trends, in technology for example, appeared equally applicable to any of the industrialized countries and that experience in the more advanced countries could indicate possible developments in Britain.

The analysis of trends and identification of a set of realistic scenarios were therefore approached by taking a "step down" from world trends to national trends, and then assessing the possible implications in South Hampshire. Each level was considered separately in turn, taking into account the implications of one for the other. The creation of three levels provided the broad structure for sorting and analyzing facts and opinions, as shown in Figure 1. Three "world futures" or scenarios were defined, each describing a gradual long-term movement from the present situation but in different directions. Space does not permit a full description of the scenarios but they can be summarized as follows (Linecar *et al.* 1981).

(1) A *technological* scenario envisages concerted action to use technology, largely techniques that already exist, to solve the world agricultural and energy problems and sustain continued economic growth.
(2) An *adaptable* scenario envisages a partial solution of the world's problems by adapting existing economic, political, and social structures to minimize the use of energy, maximize food production, and establish a spirit of cooperation between the developed and less developed countries, recognizing that the world's problems can only by solved by improved economic and political interdependence of countries.
(3) A *trend* scenario envisages the continuation of the present world problems, including continuing energy supply problems, food shortages, and sluggish growth in world trade and output.

The three scenarios provided a basis for assessing how strategic trends at the national level might develop. A list of critical areas was specified at this level (Figure 1) and then, in the final stage, an attempt was made to interpret the effects of possible national trends on South Hampshire, with special reference to a series of factors relating to land-use planning. As the authors of the study point out, this last stage required a greater degree of reasoned speculation by the planning team, as there were few other studies against which their judgments about the long-term effects on land-use planning in general, and South Hampshire in particular, could be compared.

3.2. *Information on the Impact of Interregional Fiscal Flows*

The economic and social development of a region is inevitably conditioned by the level and distribution of public expenditure in that region. Particularly important is the pattern of fiscal flows between individual regions and central government (or any other upper-level public body). Some of the fiscal flows entering a region may be the outcome of a "regional" policy on the part of central government to discriminate in favor of certain regions in its allocation of funds. Other incoming flows, however, will merely reflect the regional incidence of intersectoral allocation decisions, taken with only limited knowledge of their regional consequences. To complete the picture, there are outgoing fiscal flows made up of various kinds of taxation: here too, decisions on the level of taxation are likely to have been taken without considering regional impacts.

It is clearly important, therefore, at both inter- and intraregional levels of planning, to have detailed information about fiscal flows. Such information will be valuable in assessing the efforts made by public bodies in addressing a region's needs in the past and may also be helpful in

World scale

Basic resources	Population	Renewable resources	Nonrenewable resources	Energy
Man's reaction	World trade/ economy	Social/ political	Technological	
Possible scenarios	*trend*	*adaptable*	*technological*	

National scale

The economy
Energy costs and consumption
Technology
Public/private expenditure
Employment structure
Unemployment
Mobility
Agriculture
Social trends

South Hampshire/Land-use implications

Employment
Mobility
Housing
Shopping
Recreation

Figure 1 A structure for analyzing trends: the South Hampshire example (source: Linecar *et al.* 1981).

determining the broad priorities for public expenditure (and policy) in the future. An example of an information system created specifically for these purposes is that for the Northern Region in England (Northern Regional Strategy Team 1977). At an early stage in its work, the planning team decided that the main thrust of its strategy for the region (consisting largely of declining industrial centers) would be economic, but it was recognized that existing government statistics on public expenditure were not sufficiently comprehensive at the regional level. Working with civil servants from central government, the team produced breakdowns of public expenditure by sector and taxation for a system of eleven regions covering the United Kingdom (Short 1981). Public expenditure was defined to include only expenditure that was "regionally relevant": that is, expenditure that generates benefits that are regional in character. Expenditure that was regarded as national in character, and could not therefore be allocated to a region, was excluded from the accounts.*

Table 1 Selected items from the regional distribution of fiscal flows (DM per capita, 1975) for the Trier region and reference regions in the Federal Republic of Germany (source: Zimmermann 1980).

Fiscal flow	Trier region		Reference regions			
			Agglomerated			
	Total	County of Bitburg-Prüm	Ludwigshafen region	Mainz region	Rural county of Kusel	State of Rheinland-Pfalz
Incoming						
I. Intergovernmental:						
State grants to local governments	282	414	73	99	255	172
Federal grants for transportation	17	7	82	44	4	21
II. State and federal expenditures:						
Nonmilitary personnel	782	511	459	1,405	422	777
Buildings	92	12	70	133	–	125
Nonlocal roads	240	–	105	158	–	194
Rent subsidy	16	13	21	16	9	18
Outgoing						
(Income tax on wages)	(434)	(243)	(1,672)	(1,211)	(92)	(1,004)
(–Local share income tax)	(–148)	(–101)	(–248)	(–237)	(–153)	(–193)
=Federal and state share of income tax†	286	142	1,424	974	–61	811
Federal and state share of business tax	65	60	162	152	46	98
Motor vehicle tax	87	92	84	90	56	88

† The federal and state share is actually higher, but figures for the assessed part of the income tax are not available for the smaller subregions. This unreported part explains the negative sign for the county of Kusel, where (assessed) agricultural income is important.

Information systems based on interregional fiscal flows also have a useful role to play in assessing the impact of regional policy. At a detailed level, the direct effect of individual fiscal flows on quality-of-life indicators can be measured and interregional comparisons can be made: an example

* Examples of "national" expenditure include defense, overseas services, and prisons.

would be the effect of hospital construction grants upon hospital bed provision per capita, an indicator measuring the quality of health services.

It is possible in addition, as Zimmermann (1980) points out, to make a more general assessment of regional policy by using to the full the information contained in the fiscal flow account. Zimmermann puts forward a method for estimating the impact of fiscal flows, both incoming and outgoing, upon regional development objectives. The indicators chosen to measure progress toward these objectives are very broadly defined and include income per capita and the quantity and structure of employment opportunities. Zimmermann's method has three main stages: the construction of an information system containing data on the regional distribution of fiscal flows (Table 1 is an example prepared for the region of Trier in the Federal Republic of Germany and for several "reference" regions, to enable interregional comparisons to be made); a stage in which "shifting processes" are taken into account (because if the person receiving a payment or paying a tax loses this payment to, or gains it from, another person in that region, then that other person is the decision maker, whose decision influences the policy objectives and thus should be analyzed (Zimmermann 1980, p.141)); and a final stage in which the impact upon the regional development indicator is calculated (here it is necessary to take account of indirect, as well as direct, effects upon the indicator and so regional input—output analysis would be appropriate). Zimmermann suggests that when the overall effects of fiscal flows upon regional indicators are known, it may turn out that regional policy expenditure is overwhelmed by other fiscal flows, possibly to the extent that the effects of regional policy are more than canceled out. Information of this kind will clearly be of great value to the regional planner in arguing for future reallocation of public expenditure.

3.3. *Information for Analysis of Individual Topics within the Regional Plan*

The two types of information system considered so far are both likely to be useful in elaborating the context within which the planning of individual regions can be carried out. We turn now to the information requirements arising from the analysis of specific topics within a given region. In the first instance, the purpose of such analysis would be to define the regional (strategic) planning issues that require some kind of policy response. The range of topics to be considered in this way will obviously vary from region to region: it is likely, however, that in all cases the sources of data will include a mixture of published census data, specially commissioned surveys, and model-generated data. Much of the data will be spatially defined although the level of spatial resolution will change according to the topic being examined.

The information system for a particular topic is the product of efforts to bring these data together in a systematic and logical manner. To illustrate this, we consider the example of the analysis of transport within the plan for Greater Manchester, a metropolitan region in Northwest England. The organization of analytic work on this topic is shown in Figure 2, which indicates how the various strands of work were linked together (Greater Manchester Council 1975, Nickson and Batey 1978).

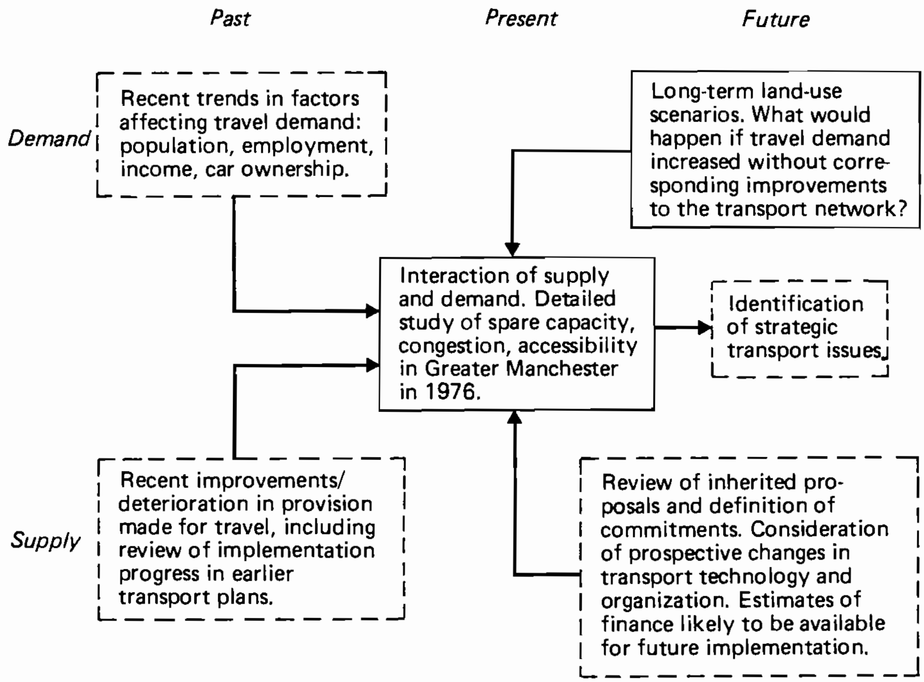

Figure 2 The organization of analytic work in the Greater Manchester Structure Plan Report of Survey on Transportation (source: Nickson and Batey 1978). Full-line boxes: model-based studies; broken-line boxes: other studies.

The main focus was on current transport problems, such as spatial and sectoral variations in accessibility, and spare capacity and congestion in the highway and public transport networks. In the absence of consistent and up-to-date survey information on these indicators, a transport model, calibrated mainly on 1960s data, was used to simulate information for the base year, 1976. This model operated at a "fine zone" level with 368 zones but, because of doubts about its reliability at that level, model results were aggregated initially to 86 coarse zones. Even at this level, the volume of output was potentially overwhelming and so to make the results as informative as possible, because of the need to define broad planning issues, it was decided to use a series of summary measures to indicate major spatial variations in network performance and potential accessibility.

Past trends in supply and demand were studied with the aid of census data (on variables influencing travel demand, such as population, income, and car ownership) and special surveys (including data on the implementation of proposals in earlier plans and on the evolution of the bus and rail networks). Other sections of the analysis were future-oriented: in the case of demand, the transport model was used to test the sensitivity of the existing networks to extreme changes in land-use and other variables influencing travel demand; while on the supply side an inventory was made of "committed" transport proposals to establish which of these would be binding to a future regional plan. Future changes in transport technology were considered and the study also included estimations of the level of finance likely to be available for future implementation of transport proposals.

3.4. *Integration of Analysis at the Regional Level*

There is a marked tendency in regional planning exercises to pay more attention to the analysis and forecasting of individual topics than to the linkages between them. An approach of this kind fails to recognize the integrated nature of regional development processes (Barras and Broadbent 1982, ch.2). It ignores, for example, the linkages between demographic and economic activity or between energy and transport, and the competition within the region for the use of basic resources such as land, labor, and finance.

Several attempts have been made to develop regional accounting systems that enable at least some of these relationships to be represented in formal, mathematical terms (e.g. Leven *et al.* 1970). Frequently, though, the development of these accounts has not been carried forward to the empirical stage because of a shortage of suitable data. Even if this shortage were eliminated, it is questionable whether these accounting systems would be sufficiently comprehensive for the purposes of intraregional planning. Instead of measuring all flows in financial terms, as most accounting systems do, it is desirable to maintain some flexibility so that the unit of measurement can be varied to include, for example, people or jobs.

A promising attempt to provide a solution to this problem can be found in the work of Barras and Broadbent (1975; Barras 1978; see also Booth and Palmer 1977, Batey and Madden 1981). This involves the generalization of economic activity analysis so that a given region or urban area can be characterized as a system of interrelated "activities," such as residential, manufacturing, and local government activity, each producing and consuming one or more of a set of "commodities," such as land, labor, floor space, and finance. These commodities, or resources, are the basic physical entities of the system, and it is through their consumption and production (these terms are interpreted in a broad sense) that the different activities are interrelated (Barras 1978, p.298). The level of detail is flexible so that, for example, residential activity could be disaggregated by location and households by social group or employment status.

In its most basic form, the activity–commodity framework is a resource-based accounting framework that records the relationships between activities in terms of commodity flows. This type of framework can be used as a data structure, ensuring consistency between data sets for different topics (e.g. matching economically active population to employment, by skill category). It is also possible to convert the framework into a linear model, suitable for use in forecasting and impact analysis, by expressing each activity as a vector of coefficients, corresponding to the quantities of commodities it consumes and produces at a unit level of activity.

Activity–commodity frameworks have yet to be widely adopted in regional planning. There are examples, however, of cases where the existing data of a planning study have been "reworked" to construct such a framework for use in impact analysis. Booth and Palmer (1977) describe an application of activity–commodity frameworks to Cleveland in Northeast England. A notable feature of their framework is its use to model spatial interaction between activities in four subregions, so that effects of a change in one subregion upon other parts of the same region can be measured.

3.5. *Information for Establishing Regional Land-Use Options*

In regions experiencing rapid urbanization, a major problem that frequently confronts planners is the location of future urban development. Policy guidance is needed on which areas of land should be developed to satisfy immediate requirements, which land can be reserved for release in the long term, which land is physically (or otherwise) unsuited to urban development, and so on. The traditional approach of the land-use planner would be to construct a sieve map, a series of detailed map overlays, each containing information about areas that should be excluded from development according to a particular criterion. The land that passed through the sieve, and thus carried no restrictions, would be regarded as that most suitable for development (Keeble 1969). This approach is open to a number of serious criticisms: Are the exclusion criteria equally important, as the approach assumes? Is not the level of detail used in the maps spuriously precise?

Land capability studies have progressed considerably since the sieve map was first introduced forty or fifty years ago. Particularly important advances have been made in the storing and handling of spatial data related to development potential. For example, in the British subregional planning studies of the late 1960s, it became almost standard practice to carry out a land development potential exercise based around spatial information systems known as "potential surfaces." Like the overlays in the sieve map approach, each potential surface was used to represent a particular development factor. The basic spatial unit making up each surface was the kilometer square: for each surface a score was assigned to each grid square. A composite score measuring overall development potential (usually for residential development) was then calculated by weighting the surfaces, according to some measure of their relative importance, and adding together the scores for each grid square (Coventry, Solihull, Warwickshire Study Team 1971).

The choice of the grid square as the basic unit for spatial information was justified on the grounds that it was a "neutral" spatial unit well suited to the integration of physical and socioeconomic development factors, and that, because it was of uniform size, a consistent assessment of land could be achieved across the entire region. There is no general consensus on this matter, however, and more recent studies have advocated point referencing (Forbes 1972: quoted in Tivy 1980); and the use of irregularly shaped "functional" units,* adopted by the Commonwealth Scientific and Industrial Research Organization in a demonstration project in New South Wales, Australia (Austin and Cocks 1978). Much of CSIRO's earlier research was focused on systematic approaches to land description and led to the development of a two-tier "land system," based on recurring, biophysically homogeneous land areas ("units" and "facets") that could be identified on air photographs, which provided a method for the rapid survey of large land areas.

Functional units were created by overlaying the biophysical land units (defined on the basis of geology and terrain, vegetation, and location: factors thought to impose major "natural" constraints on general land-use possibilities) with boundaries appropriate to tenure, planning zone, and development status (e.g. built-up, cleared, and uncleared). CSIRO argues that the functional units that emerge (ranging in size from 51 ha in coastal areas to 297 ha in the mountains) are sufficiently homogeneous with respect to their definition criteria as to be distinguished internally by the same land-use potentials and limitations. Other data assembled by functional unit include data on the coastal environment, fauna, and socioeconomic characteristics. The CSIRO study proceeds to develop methods by which exclusion rules are established and applied to identify and locate those land uses that should be discouraged. For example, "exclusion maps" were prepared for forestry, urbanization, agriculture, recreation, conservation, and residue assimilation (e.g. landfills and septic-tank disposal) and show areas on which the particular use should be excluded and where option space is available. The rules are not intended to define how land should be used, but rather to limit the range of possible uses that need to be considered and thereby, it is argued, simplify the planning process (Tivy (1980) presents a fuller discussion of the CSIRO study.)

* Harvey (1969) (among others) discusses the relative merits of grid squares and other methods of spatial representation.

3.6. *The Environmental Technical Information System*

The final example of an information system to be considered here was originally developed by the US Army Corps of Engineers as an aid in the preparation of Environmental Assessments and Environmental Impact Statements associated with the planning and location of army installations, such as military bases. The information system is known as the Environmental Technical Information System (ETIS), an umbrella term for a series of three subsystems, to be described below. ETIS contains information, much of it stored at a county level, for the entire United States (US Army Construction and Engineering Research Laboratory 1981). Because it provides a consistent and comprehensive source of local environmental, economic, and social data, ETIS has obvious nonmilitary applications, and is potentially a useful regional planning tool: in fact, it has recently been made available for use on a contract basis to this wider, nonmilitary clientele. The three subsystems of ETIS will now be described briefly.

The first subsystem, the Environmental Impact Computer System (EICS), given certain information about a proposed activity, builds a "need to consider" matrix of all likely environmental problems associated with this activity. Environmental factors are divided into thirteen "technical specialties," e.g. air quality, and for each specialty is produced a list of attributes that are specific to the locality being considered. Attributes are available at two levels of detail: a "review level" containing generalized categories and suitable for most applications where a large number of different localities are being scanned; and a detailed level to assist in cases where the choice of locality has been narrowed down to a short list. The "need to consider" matrix compares proposed activities against these environmental attributes, indicating the extent of the impact by a score. Information is also available on possible ways of mitigating adverse environmental impacts (Fittipaldi *et al.* 1979).

The Economic Impact Forecast System (EIFS) can be used to gain a broad impression of the economic impact resulting from a proposed activity. It consists of a series of eleven descriptive profiles available for each of the counties (or aggregations of counties) in the United States, together with a simple predictive model that builds upon the standard economic base technique. The information held at county level is very comprehensive and includes, for example, demographic, government and business statistics and historical trends in income, employment, and population (Hamilton and Webster 1979).

The Computer-Aided Environmental Legislative Data System (CELDS) is a collection of current federal and state environmental regulations and standards in abstracted form. Abstracts are written in a straightforward, narrative style without the use of legal jargon, the aim of the system being to provide quick access to current controls on activities that may influence the environment.

The broad scope of ETIS means that it is difficult to define precisely the part it can be expected to play in long-term regional planning. Its main application would seem to be in assessing the ramifications of large-scale developments. Proposals for developments of this kind can, of course, arise at any time during and after the preparation of a regional plan.

4. Conclusions

This chapter has explored the role of information in long-term regional planning. In a series of examples we showed, firstly, how information systems can be used to define the context for long-term planning in individual regions. We examined a procedure for the development of long-term scenarios based on a combination of informed opinion and factual information, and we drew attention to the importance of information concerning interregional fiscal flows. We next considered the systematic analysis of individual topics within a region, focusing on the example of transport, before proceeding to describe a resource-based accounting system designed to integrate the analysis of these topics. In the fifth example, we turned to the question of land use and reviewed several information systems concerned with development potential and the specification of land-use options. Finally, we described a general-purpose information system suitable for the assessment of major environmental and economic impacts.

References

Austin, M.P., and K.D. Cocks (eds.) (1978) *Land Use on the South Coast of New South Wales: A Study in Methods of Acquiring and Using Information to Analyse Regional Land Use Options* (Canberra: CSIRO), 4 vols. and 3 maps.

Barras, R. (1978) A resource allocation framework for strategic planning. *Town Planning Review* 49: 296–305.

Barras, R., and T.A. Broadbent (1975) *A framework for structure plan analysis*. CES (PRAG) Technical Papers TP8 (London: Centre for Environmental Studies).

Barras, R., and T.A. Broadbent (1982) A review of operational methods in structure planning. *Progress in Planning* 17: 53–268.

Batey, P.W.J., and M. Madden (1981) Demographic–economic forecasting within an activity–commodity framework: Some theoretical developments and empirical results. *Environment and Planning* A 13: 1067–1083.

Booth, D., and D.J. Palmer (1977) The activity–commodity framework and its application in strategic, sectoral, and spatial analysis. *Proceedings* of Seminar B: Policy Analysis for Urban and Regional Planning, PTRC Summer Annual Meeting, University of Warwick, July 1976 (London: PTRC), pp. 62–84.

Coventry, Solihull, Warwickshire Study Team (1971) *Coventry, Solihull, Warwickshire Subregional Study* (Coventry: Coventry City Council).

Department of the Environment (1970) *Development Plans: A Manual on Form and Content* (London: HMSO).

Drake, M., J.B. McLoughlin, R. Thompson, and J. Thornley (1975) *Aspects of Structure Planning in Britain*. CES Papers RP20 (London: Centre for Environmental Studies).

Fittipaldi, J.J., S.E. Thomas, and E.W Novak (1979) Computer-aided environmental impact analysis for army real estate actions: User manual. *Technical Report* N-70, US Army Corps of Engineers, Champaign, IL.

Forbes, J. (1972) Comments on information needs of the new planning system. *Report*, Department of Town and Regional Planning, University of Glasgow.

Francis, K. (1981) The monitoring of structure plans in the 1980s. *Strategic Planning in a Dynamic Society*, ed. H. Voogd (Delft, Netherlands: Delft University Press), pp. 181–192.

Greater Manchester Council (1975) *County Structure Plan Report of Survey: Transportation* (Manchester: Greater Manchester Council).

Hamilton, J.W., and R.D. Webster (1979) Economic Impact Forecast System: Version 2: User's manual. *Technical Report* N-69, US Army Corps of Engineers, Champaign, IL.

Harvey, D. (1969) *Explanation in Geography* (London: Arnold).

Keeble, L. (1969) *Principles and Practice of Town and Country Planning* (London: Estates Gazette).

Leven, C.L., J.B. Legler, and P. Shapiro (1970) *An Analytical Framework for Regional Development Policy* (Cambridge, MA: MIT Press).

Linecar, G., S. Hill, and T. Harrison (1981) Assessing the long-term context for strategic land-use proposals. *Proceedings* of Seminar A: Policy Analysis for Urban and Regional Planning, PTRC Summer Annual Meeting, University of Warwick, July 1980 (London: PTRC), pp. 69–76.

McLoughlin, J.B. (1975) Monitoring, research, and intelligence in structure planning. *Aspects of Structure Planning in Britain*. CES Papers RP20 (London: Centre for Environmental Studies), pp. 157–172.

Nickson, J.V., and P.W.J Batey (1978) The analysis of transport within a metropolitan county structure plan: The Greater Manchester experience. *Town Planning Review* 49: 285–295.

Nijkamp, P., and P. Rietveld (1982) Soft econometrics as a tool for regional discrepancy analysis. *Papers of the Regional Science Association* 49: 3–21.

Northern Regional Strategy Team (1977) *Strategic Plan for the Northern Region* (London: HMSO), 5 vols.

Parker, M. (1978) Keeping structure plans relevant. *Current Issues in Structure Planning*. Policy Series vol. 4, ed. R. Barras (London: Centre for Environmental Studies), pp. 34–45.

Short, J. (1981) *Public Expenditure and Taxation in the UK Regions* (Farnborough: Gower).

Thoenes, P. (1977) Scenarios and their external conditions. *Recent Developments in Planning Methodology* (The Hague: Ministry of Housing and Physical Planning), pp. 38–53.

Thorburn, A. (1975) Regional and structure planning in a time of uncertainty. *Report*, Town and Country Planning Summer School, Aberystwyth (London: Royal Town Planning Institute), pp. 3–9.

Tivy, J. (1980) Information for regional land-use options. *Town Planning Review* 51: 339–350.

US Army Construction and Engineering Research Laboratory (1981) The Environmental Technical Information System: Overview and user orientation. *Report*, US Army CERL, Champaign, IL.

Willis, J (1972) Design issues for urban and regional planning information systems. CES Papers WP71 (London: Centre for Environmental Studies).

Willis, J. (1974) A strategy for developing computerized information systems for local government: The end of the mega-system. *Models, Evaluations and Information Systems for Planners*, eds. J. Perraton and R. Baxter (Lancaster: MTP Construction Press), pp. 187–210.

Zimmermann, H. (1980) The regional impact of interregional fiscal flows. *Papers of the Regional Science Association* 44: 137–148.

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Elsevier Science Publishers B.V. (North-Holland)

CHAPTER 5

Monitoring and Regional Information Systems under Uncertainty

Peter J.B. Brown

1. Introduction

This chapter reviews various aspects of the activity of monitoring in urban and regional planning and the ways in which it is possible to approach the problem of handling uncertainty in the course of this activity. Particular emphasis is placed upon the roles of and requirements for different types of information and information system technology, both crude and sophisticated, in performing these tasks.

The first section outlines the evolution of thinking concerning the nature, importance, and operation of monitoring in the planning process of which it forms a crucial part. The main features of alternative modes of planning and associated approaches to monitoring are briefly described before attention is focused on the approach that has emerged as being most appropriate for application at the regional scale. This is followed by a description of the range of activities that contribute to the monitoring function and the particular requirements demanded of this function in order to accommodate various forms of uncertainty. Finally, the discussion turns to a number of problems encountered in monitoring under conditions of uncertainty, some of which are highlighted for further investigation.

Throughout the chapter examples and lessons learned from experience are drawn mainly from recent British planning practice. In Chapter 4, Batey has described various aspects of the structure plan system introduced in 1968, and has outlined some of the ways in which the advent of this system represented an attempt to develop a broad and integrated policy framework for regional planning. Attention has been drawn to the information requirements generated by efforts to make such a system rational and comprehensive and to how monitoring contributes to the establishment of a continuous regional planning process.

In practice the implementation of the structure plan system has taken longer than some expected and, following an initial intensive phase of plan preparation and submission to central government for approval, it is only more recently that county authorities have been preoccupied with the task of monitoring and reviewing their structure plan policies. With little guidance forthcoming from central government as to how this activity should be carried out, of necessity many authorities have displayed initiative and innovation in devising frameworks within which to conduct their monitoring programs. Stemming from this recent heightened concern with structure plan monitoring and review, there have emerged a number of useful reviews of underlying concepts and principles of monitoring, and a growing body of literature recording experience in the practical operation of monitoring systems, to which reference is made below.

2. Monitoring and the Planning Process

2.1. *Introduction*

The function of monitoring and the nature of the tasks it embraces vary considerably according to differences in the responsibilities, structure, and level in the planning hierarchy of the agency concerned. The demands placed on monitoring are also determined to a great extent by the mode of planning employed. In this respect, the nature of monitoring is related to a number of fundamental technical, organizational, and political issues.

It is possible to draw a useful distinction between monitoring and the process of "review," with which it is often closely associated (Department of the Environment 1975). Monitoring can be assumed to be more concerned with the continuous assembly of information and reassessment of aspects of planning policies rather than with periodic, comprehensive reevaluation that is implicit in the review process. In these terms monitoring can be viewed as a continuous "managerial" activity, whereas review is taken to imply a more discrete, fundamental, and independent activity within a planning agency, with its own information requirements. However, in parts of the discussion that follows, some blurring of this distinction may be evident as it has not been recognized explicitly in much of the literature to which reference is made.

Popular perceptions of what monitoring involves and of its role in the planning process have changed in response to the evolution of thinking about the nature of planning. Emergent theoretical and conceptual representations of the planning process have themselves reflected parallel developments in a wide range of fields, such as operations research, management science, information science, systems theory, and cybernetics, each of which has contributed to the understanding of aspects of monitoring (as described in some detail, for example, by Haynes (1974)).

It has been argued that the more recent preoccupation with monitoring and review activities is as much a practical consequence of the inability of plans and policies to cope with change and uncertainty as it is a result of advances in theoretical understanding (E.A. Rose 1979). However, much of the motivation behind this new emphasis, and behind the universal acceptance of the need for planning to be viewed as a continuous process, can be attributed to recognition of the reasons why plans and policies become obsolescent. Four reasons were identified by Cowling and Steeley (1973):

(a) It is impossible to keep track of all the assumptions that go to make up a forecast.
(b) The effectiveness of planning controls varies over time.
(c) Planning controls are slow to take effect, while social and economic change may take place quickly.
(d) The values of society may change over time, resulting in a need to change the objectives of the plan.

In Britain the increased attention devoted to monitoring in recent years can also be explained, in part, by the fact that the county "structure plan" machinery involves the formal submission of a plan for central government approval. The necessity of meeting this requirement created an impression of end-state planning, an impression reinforced by the lengthy process of plan preparation and approval. As a result, most counties gave little thought to how the statutorily approved plans would be monitored and reviewed until after the plans had been "completed" – and only then started to examine more closely the contents of the mysterious and long-neglected box labeled "monitoring," so often tacked on to schematic diagrams of the planning process.

2.2. *Monitoring and Control*

The traditional view of the role of monitoring within the planning process is that it serves as a "control" function, whereby the outcomes of planning and development procedures are observed, typically using "indicators," such as population or employment change, to detect departures from the planned course of development. Attempts are then made to identify how policies or implementation require amendment to bring the plan back "on target." This view is consistent with many features of the comprehensive–rational model of the planning process and owes much to the notions of control drawn from systems engineering and cybernetics, in particular through the treatment of monitoring as part of a process of continuous feedback, appraisal, and control to achieve specified goals (McLoughlin 1973a,b). The general process is represented in Figure 1 (Bennett 1978), based on the systems engineering approach developed by, for example, Jenkins and Youle (1971), Riera and Jackson (1971), and Harris and Scott (1974), and reflects applications of management science techniques in the planning field as described by, for example, Glendinning and Bullock (1973) and Gillis *et al.* (1974).

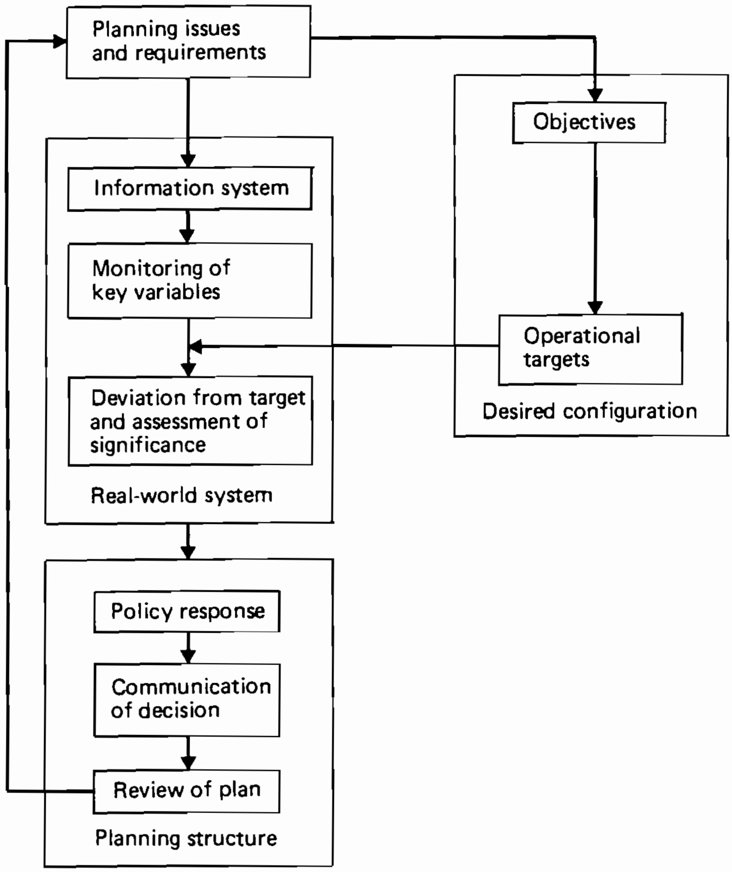

Figure 1 The "control" function of monitoring in the planning process (source: Bennett 1978).

This view of monitoring provides a useful initial frame of reference. However, familiar criticisms of the comprehensive–rational model have led to the adoption of a more flexible and responsive paradigm that places less reliance upon impractical assumptions of complete information, singular objectives, exhaustive consideration of alternatives, and rationality of decision making. As a compromise between this extreme and that of the incrementalist model, with its short-term, problem-oriented emphasis (Lindblom 1965), the adoption of the "mixed scanning" approach proposed by Etzioni (1967) has offered a much more pragmatic model, which embodies principles applicable to both the process of planning and decision making and to the operation of monitoring procedures. This model differentiates between levels of decision making and seeks to combine a broad, low-resolution scanning of issues that are likely to continue to be of planning relevance, and a narrower, high-resolution examination of those issues judged to be of greatest importance.

2.3. *Levels of Decision Making*

The influence of the level of decision making on the choice of appropriate monitoring procedures is also reflected in the classical categorization of approaches to monitoring attributable to Anthony (1965), based upon his examination of the three levels of planning and control activities in business systems that he describes as operational control, management control, and strategic planning. The associated approaches to monitoring that serve these three levels can be described as (i) implementation monitoring, (ii) impact monitoring, and (iii) strategic monitoring, respectively. These three types of monitoring activity relate to different conditions, with respect to both the degree of uncertainty about the planning environment and the degree of control that can be exercised over the issues to which the plan is directed.

Implementation monitoring is seen as simply checking that implementation takes place according to plan in conditions that are well understood and stable and in which a high degree of control may be exercised. Impact monitoring, on the other hand, is associated with managerial control and involves the assessment of whether implementation is achieving the aims of a plan, and checking the reliability of forecasts upon which it is based. Again, a fairly high level of control is assumed but some flexibility is allowed in enabling adjustments to be made to bring the system back in line. In many respects this level accords most closely with the traditional "control function" model outlined above, whereby plan and policy performance are assessed in terms of whether specified targets have been reached. In contrast, strategic monitoring is viewed as being much broader in scope. It is concerned with attempting to anticipate possible future developments and coping with a "dynamic, imperfectly understood, and imperfectly controlled environment encompassing an unlimited field of interest" (Wedgewood-Oppenheim *et al.* 1975).

This involves the review of underlying aims and objectives of a plan or policy and is directed toward the assessment of their continuing relevance. It is this approach to monitoring that is seen as being most appropriate at the regional scale. The strategic emphasis suggests an activity that is extremely wide-ranging in terms of both the issues to be examined and the information requirements it generates. Given the potential complexity of this task, it is likely that a mixed-scanning approach will be important in dealing with the problems of issue identification and information selection.

Figure 2 illustrates how the mixed-scanning approach within the three levels of monitoring, coupled with information about the requisite magnitude of control action, can be employed in establishing the point at which the adoption of a new policy target appears to be justified (Bennett and Chorley 1978).

Although this representation of how monitoring might be performed incorporates some of the concepts adopted from other fields, it still bears

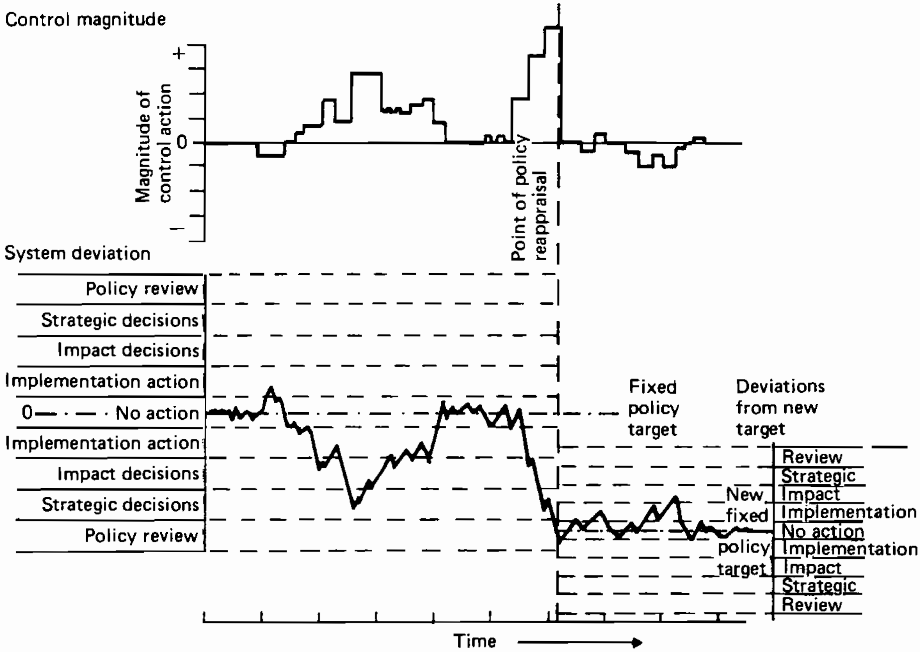

Figure 2 Mixed scanning, magnitude of control action, and policy reappraisal (source: Bennett and Chorley 1978, Figure 6.9; reproduced by permission of Associated Book Publishers Ltd., London).

a strong resemblance to a semimechanistic control function, in which the use of key indicators of plan performance and "action thresholds" of these indicators plays a crucial role. In practice, efforts to implement approaches that place reliance on such indicators have met with limited success by virtue of the fact that it is extremely difficult both to identify appropriate key indicators and to establish their critical threshold values.

2.4. *Handling Uncertainty*

More recent approaches have built upon the earlier ideas of treating monitoring and associated decisions as a process of "error-controlled regulation" within a continuous planning process (McLoughlin 1973b), and have been strongly influenced by Anthony's distinction between different models of management control, cited above. What has distinguished more recent thinking has been the explicit recognition of the nature and role of uncertainty in planning and subsequent efforts to devise ways of managing it in a creative and positive way.

Ackoff (1970) made an important contribution to the way in which uncertainty is considered in decision making by putting forward a classification of types of knowledge of the future. This distinguishes between certainty, uncertainty, and ignorance, which are equated, respectively, with three types of planning: committal, contingency, and responsiveness. It will be evident that this classification shares some parallels with Anthony's categorization of monitoring approaches, with implementation monitoring being related to "committal" and "certainty," and strategic monitoring being associated with "responsiveness" and conditions of great uncertainty or "ignorance" about the future. It has become widely accepted that it is under these latter conditions that the planner is obliged to operate, especially when attempting to get to grips with the deep-seated and complex problems encountered at the regional scale. As a result, efforts to accommodate and to plan with uncertainty, often associated with the notion of flexibility, have become absorbed into the conventional wisdom of planning in place of former, unrealistic attempts to eliminate it. Indeed, it is this recognition of the impossibility of eliminating uncertainty, and of understanding all of the implications of policy choices during the preparation of a plan, that has underlined the importance of viewing planning as a continuous process, characterized by a progressive shift toward commitment as uncertainty is reduced.

2.5. *Strategic Choice and Progressive Commitment*

Many of these efforts have stemmed from the pioneering work of Friend and Jessop (1969) and their identification of three kinds of uncertainty in planning and decision making: uncertainties attributable to imperfect knowledge of the external (physical, social, economic, etc.) environment; uncertainties as to future intentions in related fields of choice; and uncertainties as to appropriate value judgments. Consideration of the ways in which decision makers might cope more effectively with these uncertainties, and with the interrelatedness of the choices facing them, has led to a view of planning as a process of strategic choice.

It is appropriate to consider a number of aspects of this view of planning in order to reveal the extended role for monitoring that it implies. Firstly, examination of the major choices facing an agency can be expected to indicate that some are not urgent and can be deferred, and that exploratory activities, which constitute a central feature of monitoring, can be set in motion to reduce some of the uncertainties surrounding the choice (Floyd 1978). Floyd also suggests that:

> Monitoring will also be concerned with anticipating new problems and choices. Equally, monitoring should help to identify critical choices to be faced by other agencies so that sufficient time is available for the authority to try to influence the decisions that are eventually taken. Monitoring then should be much more concerned with the future rather than past changes – except insofar as an understanding of them informs future choices – than is usually found in existing monitoring processes.

Another central concept is that of progressive commitment, which stems in part from awareness of different degrees of uncertainty but also from recognition of the intercorporate nature of planning and decision making (Friend *et al.* 1974). Although an agency may wish to defer certain choices, other agencies sharing an interest or concern within the same fields of choice may require some indication of how the agency intends to act if their future cooperation is to be secured. Similarly, choice may depend to a great extent on the future intentions and decisions of these agencies. Thus, consistent with the principle of "mutual partisan adjustment" (Lindblom 1965), the agency may require to enter into some initial tentative commitment or need to secure the commitment of other agencies to particular policies or decisions that would be consistent with the agency's own intentions.

It is clear that, in these conditions, as uncertainties can rarely be resolved before a policy is formulated or a decision is taken, it is often necessary to proceed on the basis of assumptions or best guesses about key variables, other agencies' likely intentions, etc. Consequently, the checking of such assumptions and the assessment of the need to strengthen interagency commitments, or of the degree of adherence to policy guidelines and fulfillment of past commitments by other agencies, all represent crucial aspects of monitoring activity. The information system implications of the need to monitor this type of "intelligence" material will be returned to below.

Floyd (1978) points out that, in practice, undue importance is frequently attached in monitoring to what have been referred to above as uncertainties about the "operating environment," at the expense of consideration of uncertainties about possible actions of other agencies or value judgments, etc., which he suggests often turn out to be of equal, if not greater, significance. Uncertainties of the former kind tend to attract excessive attention since they are more amenable to systematic exploration. Floyd suggests that, to assist in efforts to overcome this tendency, the literature devoted to risk analysis and decision theory (e.g. Emery 1969) may prove a useful source of techniques for use in identifying issues for attention and in assessing the need for different types of information.

2.6. *The Extended Role of Monitoring*

The extended role of monitoring outlined in the above sections can be seen to embrace not only the traditional activities of assessing the effectiveness and continuing relevance of strategic plans, policies, and policy implementation but also the examination of whether new issues, changing values, unforeseen problems, and new opportunities indicate a need to modify policies or introduce new ones. This emphasis can be contrasted with the earlier approach, based on "systems theory," which was directed toward controlling deviations from a planned state. The focus has shifted toward confronting the uncertainties that underlie future choices and informing the process of progressive commitment. In this respect monitoring comes to be seen as much more than a detached technical exercise and is located at "the very focus of the coupling between technical and political activity in the planning process" (Bracken 1981).

In the United Kingdom, recognition of the key role of regular monitoring has led a number of strategic planning authorities to adopt a style of operation that is centered around an annual cycle of monitoring and review of their structure plan policies. Among the best established examples of the development of this type of approach are the systems employed by the counties of East Sussex (Thorburn 1975, 1978) and Hertfordshire (Steeley 1975, Perry and Chamberlain 1977). In the case of Hertfordshire, the process involves a sophisticated system of data assembly, screening, and reporting and the use of various techniques in the assessment of plan performance and the examination of emerging issues. The wide interpretation placed on the term "monitoring" in this context is evident from the following definition from the Hertfordshire County Council (1981):

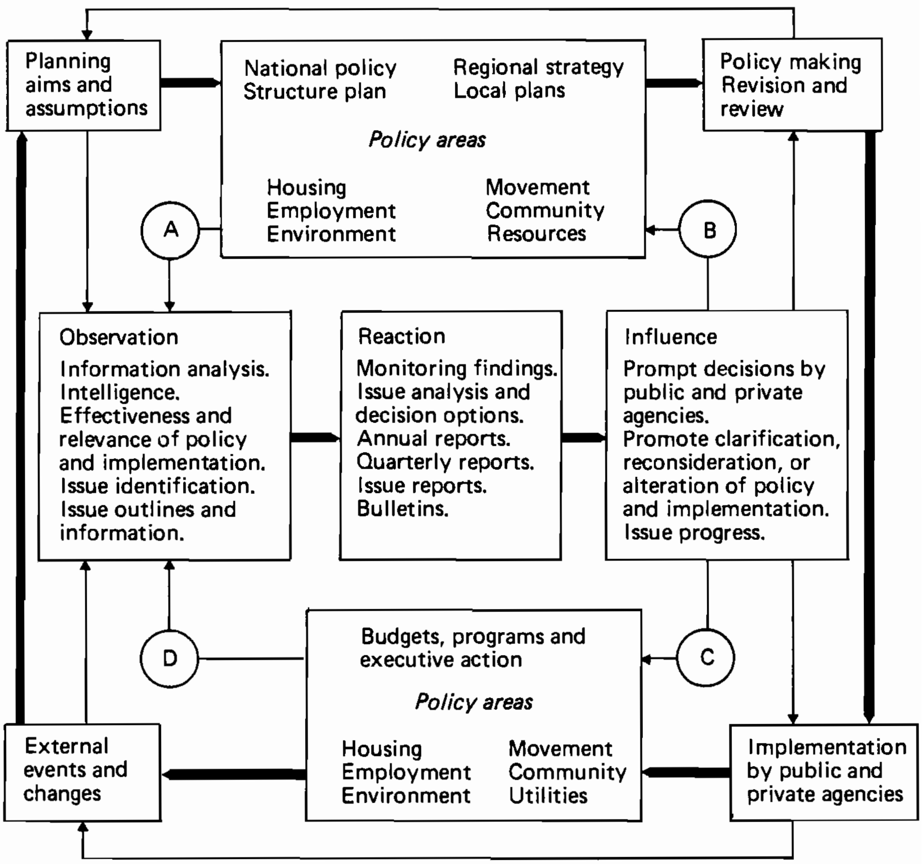

Figure 3 Continuous planning and policy monitoring (source: Hertfordshire County Council 1981).

> Monitoring can be defined as the regular surveillance of the interactions between intent and event. Accordingly, its purposes are to tap information circuits, track the course of events, detect and warn of divergence from prescribed limits, communicate selective intelligence and advice, introduce innovation, stimulate corrective or controlling action and verify results. These elements can all be traced in dictionary definitions and in the Latin derivation of the word "monitor" (*monere*: to warn or remind).

The Hertfordshire system features well developed procedures for the communication of the results of monitoring activities through a series of Annual Monitoring Position Statements, Performance Reports, Monitoring Bulletins, Issue Statements, etc., all of which inform the process represented in Figure 3. This is intended here simply to illustrate how, as part of this system, the main functions of policy monitoring (observation, reaction, and influence) relate to the surrounding context of continuous planning and policy making (at the top) and real-world action and events (at the bottom). The principal points of interaction between intent (plans and policies) and event (implementation, etc.) are represented by A to D, indicating their relationship with the monitoring activities associated with observation, reaction, and influence.

3. Implications for Monitoring and Regional Information Systems

3.1. *The Scope of Monitoring*

The preceding discussion of the evolution of thinking about the role of monitoring in the planning process underlines the fact that no single approach or procedure is appropriate for application in all circumstances. It is clear that the range of tasks involved in performing the monitoring function will be different at different levels or scales of planning activity and that the range of information needs to support these monitoring tasks will also vary widely, depending upon the emphasis placed on the different aspects of monitoring that have been identified.

In the establishment of monitoring procedures it is essential to be clear about the objectives to be pursued in performing monitoring activities and the regional planning and policy-making needs that are to be served by monitoring. In this respect it is important to recognize that regional agencies that exercise different powers or responsibilities will have different priorities. Thus, the requirements of an agency with a brief restricted to one sector or a limited set of issues (e.g. population or demographic issues; see, for example, Scheurwater and Masser 1981, Gordijn and Heida 1981) are likely to be different from those of the type of agency considered here, which is taken to have a broader range of responsibility for the development of "comprehensive" regional plans and policies.

Bennett (1978) suggests that the aims of regional monitoring systems serving the latter type of agency can be summarized in general terms as "the rapid provision of information, the effective control of planning authorities within a region, the implementation and coordination of joint decisions, and the organization of finance and structuring of capital programmes." However, within these broad aims there remains a wide range of political choice as to which issues should be the focus of monitoring attention in terms of the assessment of policy effectiveness, etc. Bennett identifies a number of issues, which here serve simply to indicate the extent of this choice, each of which can generate the need to establish monitoring machinery to aid the early detection of significant shifts or changes that are likely to affect the realization of policy, and to provide guidance as to the alternative courses of action required in response:

- impact of national economic policies and trends at regional level;
- effect of central government policy, infrastructure investment, etc.
- government grant allocations, nationalized industry decisions, etc. with a regional significance;
- impacts of major investment projects, e.g. regional airports and new towns;
- decisions of other regional bodies with respect to service provision, employment, etc.
- nature and effect of local authority decisions;
- disparities in income, amenity, and opportunity within and between regions;
- changes in local values and behavior affecting policy;
- technological changes and innovations.

3.2. *Information and Data-Handling Requirements*

Concern with such a potentially "unlimited field of interest" (from the earlier definition of strategic monitoring) suggests an equally great potential demand for information to support the monitoring function. To indicate how this demand might be met, and to introduce discussion of some of the problems associated with using such information in the implementation of monitoring procedures, it is useful to draw upon a general conceptualization of the monitoring process put forward by Haynes (1974). For this purpose, Figure 4 indicates that, as part of a management function, monitoring activities are undertaken at the interface between the "information field" and the "problem identification" function. Haynes suggests that the information field can be taken to represent all of the unstructured information that can be tapped and channeled through the monitoring process into the management system. This information he classifies according to the following types:

(1) information about the developing state of the system;

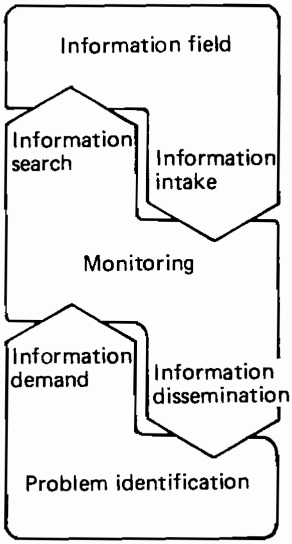

Figure 4 Relationship between monitoring, the information field, and the problem identification function (source: Haynes 1974).

(2) information about actual system "intrusions," or changes incurred endogenously and exogenously by the system;
(3) information about proposed or potential system "intrusions";
(4) new knowledge about system processes and behavior (empirical and theoretical);
(5) new knowledge of planning and management technology.

Haynes goes on to outline the function of monitoring activities as being to select relevant information from the information field, analyze and organize that information, and disseminate it to the appropriate user. This he describes as involving the following tasks:

(1) sensing of information;
(2) screening of information;
(3) structuring of information;
(4) storage and retrieval of information;
(5) presentation and communication of information.

Most of these tasks are identical to those that may be associated with the operation of any information system and are adequately discussed elsewhere (e.g. Nijkamp 1982). However, it is appropriate here to draw attention to some of the ways in which their performance for the specific purpose of monitoring presents particular difficulties or unusual requirements.

Earlier discussion has implied that the information requirements of a regional monitoring system are likely to be extremely diverse in terms of the types, sources, spatial scales, time scales, etc. of the data employed. This in turn suggests the need to develop a high degree of capability with respect to the above tasks in handling not only "hard," quantitative information but also a variety of forms of "soft," qualitative information, a topic returned to below. Recognizing that the hardest of facts are open to varied interpretations, some would prefer to describe all information as "squashy" (like a tomato), since it is valuable only if handled with care and not asked to support too much (Thorburn 1978).

3.3. *Hard Information*

Much of the hard, quantitative information of value for monitoring purposes can be derived from official sources in the form of statistics published by central and local government bodies on a regular basis. Other data may be obtained from internally produced reports, management information, etc., by intercepting existing flows of operational data generated in other departments or agencies, or as a result of data collection activities undertaken by the regional agency itself. However, monitoring shares with other analytic endeavors a number of fundamental problems that are associated with the use of information drawn from such a wide range of different sources. The incompatibility of the geographic areas for which different statistical series are compiled is a common problem but, in the case of monitoring that is directed toward identifying significant trends, rates of change, evolving interrelationships, etc., this is compounded by the collection and publication of statistics over different time scales – monthly, quarterly, annually, etc. This raises problems as to how such data series can best be stored and processed in order to facilitate the study of links between different series. In this connection, in the development of computer-based information systems to support monitoring activities, the extension of spatial referencing techniques to accommodate the temporal dimension requires particular attention. A data dictionary or directory, containing not only detailed specifications of each series but also the links between them, is an essential requirement.

3.4. *The Intelligence Function*

Discussion of the nature of uncertainty in planning and decision making has emphasized the importance of the intelligence function as a component of monitoring. This function includes the collection of qualitative information, both hard (e.g. policies approved, commitments made, and events that have occurred) and soft (e.g. information on emerging policies, proposals under consideration, assessments of problems, comment, rumor, and public opinion). The sources of such information are virtually infinite and the procedures used to sense and scan such material will therefore need careful attention and regular review to ensure that relevant information is channeled into the monitoring/decision-making process. It is this need to draw on all types of information and to digest and translate the information into a policy-relevant form that distinguishes the intelligence activity from more conventional modes of data gathering.

Qualitative information of this type, by its very nature, is difficult to structure and process (Francis 1981). What is required is some means of storing information so that relevant items can be extracted that relate to a range of different concerns. Better known examples of the use of less complicated technology for this purpose include the systems developed, with some success but on only a modest scale, by the Nottinghamshire/Derbyshire Monitoring and Advisory Unit (Gillis *et al.* 1974) and Hertfordshire County Council (Perry and Chamberlain 1977), which feature the use of manually sorted edge-punched cards. A summary of information is stored on the cards, holes around the edges are coded by topic, date, etc., and a card is retrieved by specifying an appropriate combination of codes. However, computer technology is providing increasingly powerful means of storing, collating, and interrogating combinations of statistical and textual material via the use of keywords, strings, etc., and this promises to facilitate the efficient handling of such information. Even so, there remain many problems relating to the establishment of the principles on which to base the structuring and storage of this sort of information so as to maximize speed of access while not imposing unreasonable data capture and processing costs. In the case of hard data these costs are often shared between user agencies, etc., but intelligence material may well be only of value to the agency itself and will often have a very short "shelf life" in which to pay for itself.

3.5. *Selectivity in Data Assembly: The User's Case*

A number of general points that have emerged from monitoring practice suggest that, in order to achieve greater effectiveness, it is more important to increase the speed of response to, or recognition of, conditions calling for action (Stamper 1973) and to increase the range of variables taken into account than to increase the amount of detail on each variable (Wedgewood-Oppenheim *et al.* 1975). One of the most difficult issues to deal with satisfactorily is the selection and screening of information. The problem is generally not one of assembling enough information but rather one of filtering out the overwhelming abundance of surplus irrelevant material that, solicited or not, is typically absorbed by monitoring and management information systems (Ackoff 1967).

In Chapter 3 of this book, Peters has described the ways in which the control of information represents à considerable source of power at the disposal of the planner. Referring to Forrester (1982), he outlines how this power of information and misinformation can be exercised. Bracken (1981) has also drawn attention to the need to recognize, in the development of monitoring systems, the variety of ways in which information and data can be used by decision makers in practice. He emphasizes the importance of an awareness of the typical decision maker's suspicion of hard data, the tendency more readily to accept information that can be easily understood or to accept the validity of certain types of information or indicators and to reject others. R. Rose (1972) has suggested four factors that may account for these perceptions of relevance and that can be treated as "costs" to be associated with the assembly and processing of data as part of a monitoring operation.

The first of these costs is incurred in obtaining information, no matter how readily available from published sources, taking into account the need for skilled manpower to undertake analyses and provide selected information in a usable form. Secondly, there is the "cost in value" conflict. This relates to the tendency to reject information that appears to be in conflict with the established views and values upon which past policy making has been based or that served as justification for favored policies. This can result in controversial matters being starved of data and, conversely, less controversial issues receiving greatest attention. The third set of costs relates to "action," and concerns the utility assigned to new information that may imply a disturbance of the status quo and point to the need for "unwelcome" action. In contrast, the fourth set of costs is associated with "inaction," and might arise if it becomes evident that maintaining current policies or the status quo is increasingly difficult in the face of changed circumstances. In these conditions the policy maker may suddenly request "new information" and wish to be seen to be "doing something."

In summary, Rose suggests that policy makers can be expected to sanction monitoring if they perceive the utility of the information gathered to be greater than the "costs" that can be set against it. Furthermore, he proposes that the most effective way of ensuring that policy makers make use of data and information, and are sympathetic to monitoring initiatives, is to link this utility to the costs of inaction. Although the value of new information is not always easy to assess, he suggests that monitoring can often reveal the costs of inaction to policy makers, who would prefer to be informed of impending problems rather than be accused of lack of foresight and be blamed for failing to anticipate them.

3.6. *Filtering and Structuring Data*

Various approaches can be adopted to the process of filtering information. One approach is based upon the principle of "monitoring by exception" (Ackoff 1967), whereby data that merely confirm earlier predictions or expectations are excluded, and only "exceptions," which indicate the need to modify current policies or plans, are retained and passed on to decision makers. This introduces a risk of blocking positive feedback and ignoring information that cumulatively might become significant (Haynes 1974). Other approaches concentrate attention on "core" data (Merseyside County Council 1976) or "key" variables or series, which are judged to provide an adequate indication of "changes which are known to have widespread ramifications in the region" (Wedgewood-Oppenheim ***et al.***

1975). The choice of variables used for this purpose is itself an issue that must be kept under regular review, and Wedgewood-Oppenheim *et al.* emphasize the importance of devising a suitable control system to regulate the mixed-scanning process. They describe such a system and outline the principles that might assist in determining "the balance between the degree of effort put into data collection as against analysis, and into the routine study of areas of known relevance against investigating new sources of possible interest."

The processing and structuring of information clearly represent crucial operations in achieving a reduction in the quantity of data to proportions that can be more readily absorbed and interpreted. This can involve a wide range of methods of aggregation, summary indices, graphic techniques, etc. in revealing significant spatial patterns and trends. At this point it is appropriate to note further sources of uncertainty associated with the use of data assembled in a regional information system for monitoring and other purposes. These include statistical uncertainty, which is attributable to the necessity of deriving much information from samples of observations that may be of widely varying reliability in terms of their representation of the populations from which they are drawn. Another source of uncertainty is associated with aggregation, or data compression, whereby probabilistic variables are summarized by single or summary measures, which are then used as key indicators to influence judgments on policy. This represents a form of uncertainty absorption that takes place when inferences are drawn from a body of evidence and the inferences, instead of the evidence itself, are then communicated (Emery 1969). Although such indicators may serve as an efficient means of summarizing a mass of information, it is often important to retain access to the original raw information so that it can be reinterpreted as new problems emerge or be analyzed from new perspectives (Wedgewood-Oppenheim *et al.* 1975).

3.7. *Policy Monitoring: Understanding the Nature of Policies*

Experience has demonstrated that the way in which planning policies are expressed can have a major influence on the extent to which it is possible for an agency to undertake accurate and valid monitoring of their effectiveness. There are various reasons for this. Firstly, policies are often specified in such a form that making any quantitative assessment of achievement is difficult. This reflects the choice between setting precise policy objectives and targets and adopting less specific or even intentionally vague wording that is open to a wide range of interpretation. Although in the former case a policy may be more easily monitored, it may leave the agency vulnerable to criticism when underachievement is revealed. On the other hand, in the latter case the agency is able to retain flexibility and to make subtle changes in implementation without drawing public attention to what in reality may be a major shift in a policy target. Thus, a quest for clearly monitorable policies may well conflict with the desire to maintain the flexibility of action that imprecise policy wording can provide.

This emphasizes the need for a clear understanding of the nature and underlying meaning of policy statements if monitoring activities are to provide indications of an agency's performance (Bracken 1981). In this connection Friend (1977) makes a useful distinction between policies that set limits on expected outcomes (assuming successful implementation) and policies that prescribe the way in which a choice of action should be made. Floyd (1978) has noted that, in practice, many strategic planning policies belong to the latter category and are not designed to secure specific implementation but rather to set the context for subsequent decisions, especially when the cooperation of other agencies is required to bring about action.

It has already been described how the monitoring of this form of "progressive commitment" relies to a great extent on the assembly and interpretation of soft "intelligence" material and therefore calls for careful judgment and the use of techniques of data handling, etc. that are still relatively poorly developed. Although it is generally thought that prescriptive policies, which have more explicit objectives and implications, are capable of more precise quantitative assessment, this type of monitoring activity is not without its problems.

The use of output indicators to measure the attainment of programs against specified targets is an approach that has been widely applied in the planning and implementation of specific projects, and it has an important role in what have been described above as implementation and impact monitoring. Although central to the "control" view of monitoring, the extent to which the monitoring of similar forms of key indicator can be relied upon to measure the attainment of broader regional policies and objectives is widely disputed. It has already been noted that the lack of clarity of objectives and policies renders it difficult to isolate suitable performance criteria and "in many ways the simple ratios, percentages, and indices which have to be adopted are too gross to reflect the true complexity of regional strategies" (Bennett 1978). Such criteria are better termed "performance characteristics," as suggested by Boyce *et al.* (1972), rather than being treated as true measures of attainment. In addition, it is rarely possible to distinguish policy effects from other autonomous components of change (Bracken 1981). Nevertheless, simple indicators are still required to allow "the rapid and cheap monitoring of the direction, magnitude, structure, and dynamics of any change which is registered" (Bennett 1978). In this respect tracing changes in such indicators will be of greater importance in identifying issues for closer or "higher-resolution" attention in the mixed-scanning process than as a means of measuring the effectiveness of policies.

The use of social indicators (Carlisle 1972) and of more complex multidimensional profiles (e.g. Nijkamp 1979) has received increasing attention in efforts to increase the richness of description of urban and regional problems. Although changes in such indicators and profiles have proved valuable in revealing changes in the incidence of particular problems and conditions, again there remains the underlying methodological problem of isolating the amount of change that can be attributed to policy intervention. This persistent problem limits the extent to which such indicators can serve as measures of policy attainment or effectiveness. In this connection it is interesting to note that various attempts have been made to relate monitoring procedures to regular or annual community preference surveys (e.g. Mobbs 1975, Floyd 1978). The principle underlying this approach is that effective participation programs will generate new information about the public's changing perceptions of problems, priorities, and the effects of planning policies and will therefore help to increase the relevance of monitoring to the tackling of current social issues and problems.

Finally, on the issue of policy monitoring, in the context of uncertainty about economic, political, and social changes and imperfect understanding of these systems, there is a need to be concerned as much with identifying and evaluating the unintended and unforeseen consequences of plans as with those that were intended. However, the intentions of the original policy makers are likely to be of less significance than whether a policy is actually working in terms of contributing to the resolution of present-day problems and to meeting future needs.

4. Concluding Comments

This chapter has set out to review various aspects of the process of monitoring in urban and regional planning under conditions of uncertainty and to highlight certain issues that have particular significance when monitoring is undertaken at the regional scale. In the later sections, attention has been focused on a number of outstanding practical problems encountered in the implementation of monitoring procedures in terms of data selection, handling different types of data, and assessing the effectiveness of policies and plans. Of necessity the discussion has been extremely selective and many important issues have not been more than touched upon, such as the relationship between monitoring and forecasting, appropriate techniques for use in analyzing monitored information, problems of communicating and presenting the results of monitoring activities, and the location of the monitoring function within the organizational structure of the regional agency concerned. However, it is believed that a number of the matters raised in the discussion of the topics that have been included represent some of the key problems that require closer examination and research in order to improve the effectiveness of information systems for use in monitoring at the regional scale.

References

Ackoff, R.L. (1967) Management misinformation systems. *Management Science* 14:147–156.

Ackoff, R.L. (1970) *The Concept of Corporate Planning* (New York, NY: Wiley-Interscience).

Anthony, R.N. (1965) *Planning and Control Systems: A Framework for Analysis* (Cambridge, MA: Harvard Graduate School of Business Administration).

Bennett, R.J. (1978) Regional monitoring in the UK: Imperatives and implications for research. *Regional Studies* 12:311–321.

Bennett, R.J., and R.J. Chorley (1978) *Environmental Systems: Philosophy, Analysis and Control* (London: Methuen).

Boyce, D., A. Farhi, and C. McDonald (1972) The refinement of procedures for continuing metropolitan planning: A progress report, University of Pennsylvania, Philadelphia, PA.

Bracken, I. (1981) *Urban Planning Methods: Research and Policy Analysis* (London: Methuen).

Carlisle, E. (1972) The conceptual structure of social indicators. *Social Indicators and Social Policy*, eds. A. Shonfield and S. Shaw (London: Heinemann) pp. 23–32.

Cowling, T.M., and G.C. Steeley (1973) *Sub-Regional Planning Studies – An Evaluation* (Oxford: Pergamon).

Department of the Environment (1975) Principles of monitoring development plans. *Structure Plan Note* 1/75, DOE, London.

Emery, J.C. (1969) *Organisational Planning and Control Systems* (New York, NY: Collier–Macmillan).

Etzioni, A. (1967) Mixed scanning: A third approach to decision making. *Public Administration Review* 27:385–392.

Floyd, M. (1978) Structure plan monitoring: Looking to the future. *Town Planning Review* 49:476–485.

Forrester, J. (1982) Planning in the face of power. *Journal of the American Planning Association* 48:67–80.

Francis, K. (1981) The monitoring of structure plans in the 1980s. *Strategic Planning in a Dynamic Society*, ed. H. Voogd (Delft: Delftsche Uitgeversmaatschappij), pp.181–192.

Friend, J.K. (1977) Dynamics of Policy Change. *Long Range Planning* 10:40–47.

Friend, J.K., and W.N. Jessop (1969) *Local Government and Strategic Choice* (London: Tavistock).

Friend, J.K., J.M. Power, and C.J.L. Yewlett (1974) *Public Planning: The Inter-Corporate Dimension* (London: Tavistock).

Gillis, J.D.S., S. Brazier, K.J. Chamberlain, R.J.P. Harris, and D.J. Scott (1974) *Monitoring and the Planning Process* (Birmingham: Institute of Local Government Studies, University of Birmingham).

Glendinning, J.W., and R.E.H. Bullock (1973) *Management by Objectives in Local Government* (London: Knight).

Gordijn, H., and H. Heida (1981) Demographic monitoring and review. *Strategic Planning in a Dynamic Society*, ed. H. Voogd (Delft: Delftsche Uitgeversmaatschappij), pp.225–231.

Harris, R., and D.J. Scott (1974) The role of monitoring and review in planning. *Journal of the Royal Town Planning Institute* 60:729–732.

Haynes, P.A. (1974) Towards a concept of monitoring. *Town Planning Review* 45:5–29.

Hertfordshire County Council (1981) Monitoring future directions: Some initial thoughts for discussion. *Internal Working Paper*.

Jenkins, G.M., and P.V. Youle (1971) *Systems Engineering: A Unifying Approach in Industry and Society* (London: Watts).

Lindblom, C.E. (1965) *The Intelligence of Democracy: Decision Making Through Partisan Mutual Adjustment* (New York, NY: Free Press).

McLoughlin, J.B. (1973a) *Urban and Regional Planning: A Systems Approach* (London: Faber).

McLoughlin, J.B. (1973b) *Control and Urban Planning* (London: Faber).

Merseyside County Council (1976) *Progress in Housing Stock Monitoring* (Liverpool: Merseyside C.C.).

Mobbs, T. (1975) A continuous survey of citizens in Cleveland. *Proceedings* of Seminar: Corporate Planning Organization and Research and Intelligence Techniques, PTRC Summer Annual Meeting (London: PTRC), pp. 126–133.

Nijkamp, P. (1979) *Multidimensional Spatial Data Analysis and Decision Making* (Chichester;New York, NY: Wiley).

Nijkamp, P. (1982) Information systems for multiregional planning. *Collaborative Paper* CP-82-27, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Perry, H.A., and K.J. Chamberlain (1977) Hertfordshire – Monitoring and the ongoing review process. *Proceedings* of Seminar B: Policy Analysis for Urban and Regional Planning, PTRC Summer Annual Meeting (London: PTRC), pp. 137–149.

Riera, B., and M.R. Jackson (1971) The design of a monitoring and advisory system for subregional planning: A study by ISCOL Ltd., Nottinghamshire/Derbyshire Subregional Monitoring and Advisory Unit.

Rose, E.A. (1979) Monitoring and review in the planning process: Some practical problems. *New Trends in Urban Planning*, ed. D. Soen (Oxford: Pergamon), pp. 22–37.

Rose, R. (1972) The market for policy indicators. *Social Indicators and Social Policy*, eds. A. Shonfield and S. Shaw (London: Heinemann), pp. 119–141.

Scheurwater, J., and I. Masser (1981) Monitoring spatial planning in the Netherlands: An outline of an information analysis system. *Strategic Planning in a Dynamic Society*, ed. H. Voogd (Delft: Delftsche Uitgeversmaatschappij), pp.193–204.

Stamper, R. (1973) *Information for Business and Administrative Systems* (London: Batsford).

Steeley, G.C. (1976) Strategic policy monitoring, meta-information and decision making. *British Urban and Regional Information Systems Association Newsletter* 25.

Thorburn, A. (1975) Regional and structure planning in a time of uncertainty. *Report* of Town and Country Planning Summer School, Aberystwyth (London: Royal Town Planning Institute), pp. 3–9.

Thorburn, A. (1978) Monitoring of strategic planning policies. *Paper* presented at PTRC course on The Monitoring Process in Planning, London, April.

Wedgewood-Oppenheim, F., D. Hart, and B. Cobley (1975) An exploratory study in strategic monitoring. *Progress in Planning* 5: 1–58.

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CHAPTER 6

Information Systems and Uncertainty in Planning

Edwin Hinloopen and **Peter Nijkamp**

1. Introduction

Information systems, which include modeling activities, statistical tests, (dis)aggregation procedures, transformations, and computer packages, serve to reduce the uncertainty or lack of insight in planning and decision making. Although these systems may eliminate part of the uncertainty implied by a certain planning or decision problem, the uncertainty will never be entirely removed (Rizzi 1982).

Uncertainty is a basic ingredient of planning and policy making, and may lead not only to biased decisions but also to delayed decisions. Very often decisions are postponed because of insufficient knowledge about the consequences of a certain action. Such a delay is indeed reasonable if the extra time is used to gather more information. If this were not the case, the costs of delaying a certain decision might make it necessary to take one immediately. Ideally, if no such costs were involved, it would be better to leave open all relevant options until perfect insight had been achieved.

If a certain planned action is *irreversible*, the information gathered is decisive for the long-run success of the solution to the particular planning or decision problem. Irreversible actions require careful consideration based on reliable information. Clearly, if no transaction costs were involved in reversing a certain action, there would normally be no need to postpone a decision.

Various kinds of uncertainty may occur in different stages of a planning or policy problem (a review has been made by Voogd (1983a)). A sample of modern methods for dealing with uncertainty will briefly be discussed here.

A first kind of uncertainty may emerge if decisions are to be taken on medium- or long-term actions, characterized by lack of insight into the ***structure*** of the decision problem. This means that the "decision environment," i.e. the available options, the political priorities, and the expected consequences of actions, are to a high degree unknown. This is a regular phenomenon in strategic choice problems (Friend and Jessop 1969, Friend *et al.* 1974). A powerful instrument for analyzing uncertainty in such cases is *scenario analysis*. This will be discussed in Section 2.

A second category of uncertainty arises if decisions are to be taken regarding a well defined choice problem (i.e. all alternative actions or options are known, and all judgment criteria are specified), for which, however, no quantitative results or priorities (e.g. weights) are known. That is, only qualitative information (e.g. "yes" or "no," binary information, or ordinal information) on the impacts of decisions and the priorities of decision makers is available. For dealing with such uncertainty, *qualitative evaluation methods* are appropriate. These will be discussed in Section 3.

Another source of uncertainty may be lack of insight into the *dynamics* of a complex multicomponent and multiactor system, so that the moment at which a certain policy should come into action is uncertain. Even with a well defined decision problem, characterized by quantitative information about the outcomes of alternative actions, it may still be uncertain when certain decisions should be taken. Very often a "management by exception" strategy is adopted, whereby a certain policy will only be put into effect if a critical threshold is surpassed. Clearly, such cases require permanent monitoring, for which the so-called *early warning system* is increasingly being used (Section 4).

Apart from the structure, level of measurement, and complex dynamics of choice problems, another reason for lack of insight may be the inability of decision makers and experts to use modern computers as learning tools in an interactive way. In the past decades a wide variety of information systems for aiding public policy making have been designed. The introduction of computers increased the scope and range of such systems. Simulation models, game-theoretic approaches, mixed-scanning mechanisms, and learning-adaptive systems have all demonstrated the importance of modern hardware and software for decision making. In Section 5, attention will be focused on recently designed decision support systems.

The above-mentioned methods are by no means mutually exclusive but, on the contrary, may be complementary to each other.

2. Scenario Analysis

2.1. *General Introduction*

Scenario analysis is one of the methods of prospective policy research that have become very popular since the late sixties. Scenario analysis may be especially appropriate in the case of unstructured decision problems with uncertain outcomes. A major difference between scenario analysis and conventional methods of policy analysis is that scenarios contain not only a description of one or more future situations, but also a structured description of a consistent series of feasible events that reflect the transition from the present state of a certain system to its future state(s).

Figure 1 shows that a scenario analysis contains three components: the present state, future states, and paths from the present to the future. Each component must be a part of the scenario analysis, otherwise the scenario will not provide useful information for a better organization of the choice problem. For instance, if there is no description of the present situation, it is very likely that the construction of the future situations and the paths that may lead to them will be based upon incorrect assumptions. This is especially a danger in contrast scenarios (to be described later).

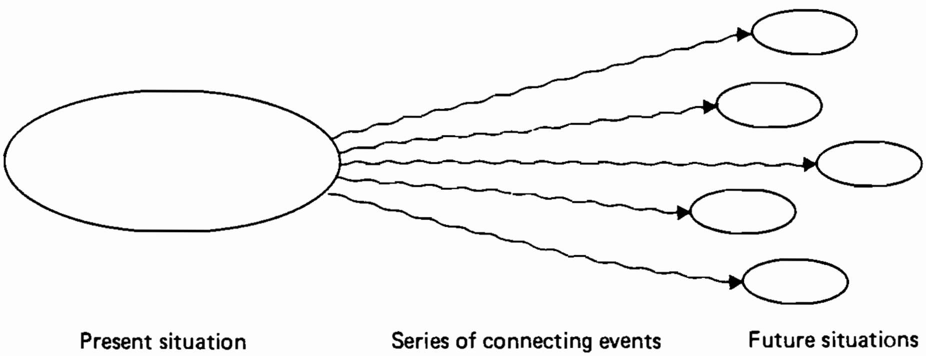

Figure 1 Illustration of scenario analysis.

Depending on the specific circumstances under which a scenario is constructed, these components may require differing degrees of attention. If, for instance, a scenario is constructed for a problem for which the actual state has already been examined in detail, then evidently most emphasis can be placed upon the two other components. On the other hand, if the paths from the present to the future are well known, only a brief description will be sufficient for a meaningful scenario analysis. Finally, sometimes the future may be surrounded with so many uncertainties that it is hardly possible to describe a plausible future situation. In such cases, the feasible paths to the future may be the main topic of discussion.

2.2. *Specific Characteristics*

Scenarios can be distinguished in four ways, according to van Doorn and van Vught (1981):

(a) A scenario may be either *descriptive* or *normative*. The prospective paths and pictures of a descriptive scenario are based on the know-how developed in the past and present. The question whether or not these paths and pictures are desirable is not raised. The first scenarios designed by Herman Kahn (Kahn and Wiener 1967) fit this description. The construction of normative scenarios is based upon the subjective ideas of the scenario writers or scenario users, who select the future paths and pictures. The so-called Ozbekkan scenarios, as a reaction to Kahn, may be regarded as normative (van Doorn and van Vught 1981). In practice, however, the distinction between descriptive and normative scenarios is not very sharp. Clearly, a descriptive scenario may also have some normative elements (sometimes implicitly).

(b) Another distinction that can be made is in the *direction* of the scenario analysis. If future pictures are based upon the present situation and future paths, the scenario is said to be *projective*. On the other hand, if the future situations are determined first, and then the paths leading to them, in fact these paths lead from the future back to the present. The scenario then belongs to the class of *prospective* scenarios. Prospective scenarios are always normative, while projective scenarios are either descriptive or normative.

(c) A scenario can be characterized either as a *trend* scenario or as an *extreme* (or *contrast*) scenario. Trend scenarios are in fact an extrapolation of the present situation. Extreme scenarios, on the other hand, comprise future paths and situations that are considered to be feasible in principle, though from the present point of view sometimes unlikely. Both types of scenario are projective.

(d) The last distinction is between a normative scenario based upon the preference of the majority of people and one that is based on the preference of a small minority. The first group may be characterized as "*common opinion*" scenarios, and the second as "*happy few*" scenarios.

The relationships between these characteristics are shown in Figure 2.

On the basis of Figure 2, various compound scenarios can be constructed, each made up of features of the successive individual scenarios. This is illustrated in Table 1, where the entries $S_{I,1}, \ldots$ indicate a blend of characteristics of various scenarios.

It is assumed in Table 1 that state 1 is a trend, while the remaining states, $2, \ldots, N$ are alternative feasible (maybe sometimes extreme) states of the system. The (linear or nonlinear) combination of these states forms the external boundaries of all possibilities of the system. The policy priorities are represented by the common opinion I, the normative (maybe sometimes extreme) priority scheme II ,..., (e.g. the happy few), and the endogenized priority responses to the external conditions $(1, \ldots, N)$, indicated by XI ,..., . The latter category is by its very nature essentially a set of descriptive scenarios.

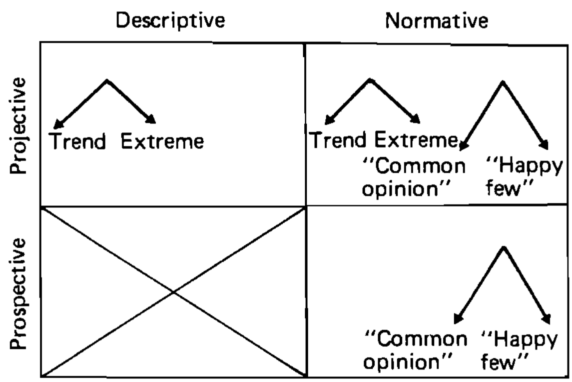

Figure 2 Characteristics of scenarios (source: van Doorn and van Vught 1981).

Table 1 Various compound scenarios, constructed from states S of exogenous conditions.

Societal value		External condition				
		1	2	3	...	N
Common opinion	I	$S_{I,1}$	$S_{I,2}$	...		$S_{I,N}$
Normative priority	II	$S_{II,1}$				
	.	.				
	.	.				
	.	.				
Endogenized priority	XI	$S_{XI,1}$				$S_{XI,N}$
	.	.				.
	.	.				.
	.	.				.

2.3. *Illustration of Scenario Analysis for Regional Development*

This section will discuss an example of scenario analysis for regional development in the Netherlands (Verbaan *et al.* 1982), starting in 1966 when the *Second Report on Physical Planning* was published by the Ministry of Physical Planning. In this document an analysis has been made of spatial and social developments in the Netherlands since the Second World War. This analysis was the basis on which the expected picture for the year 2000 was constructed, using the expected population growth and the expected growth in welfare services as the main trends.

The results of these two assumptions indicated that there would be an increase in leisure time, an increase in mobility, and a desire for more spatial choice options. The spatial consequences were a large sprawl of urban areas, a great quantity of recreation areas, and an increase in transportation infrastructure. The government policy was to anticipate as much as possible these expected developments.

Although the report was not presented as a scenario, it complies with the description of a descriptive (no desirable future images had been selected), projective (the path started in the present and terminated in the future), and trend scenario (the two major developments were extrapolated). Hence, this document is of the same kind as the scenarios of Herman Kahn.

However, a few years later the assumptions on which the forecasting had been based turned out to be incorrect. In particular, the population growth had been overestimated. Therefore, the report had to be revised, and in 1974 the first part of the *Third Report* was published. In this note, special attention was paid to three issues that had been neglected in the previous document: the environment, unlimited economic growth, and the inequity and imbalance in the development of certain parts of the country. The results of the new analysis were published more recently in the second and third parts of the *Third Report on Physical Planning*: the *Urbanization Report* (1976) and the *Report on Rural Areas* (1977).

These documents were quite different from the *Second Report*. In the first place, the relevant planning period ends around 1990. Secondly, the document does not contain only one expected future situation. Finally, it does not select one of those future pictures as the one that should be pursued.

Several quantitative and qualitative investigations have been made in order to design valid scenarios for this report. Forecasts have been made of national and regional demographic developments, the demand for dwellings, national and regional labor markets, and transportation developments.

The qualitative forecasts required the development of four scenarios: a trend scenario, very similar to the *Second Report*; a second scenario in which the main issues are intense urban growth and a strong development of international relations; a third scenario describing an environment-conscious and energy-saving future situation; and the last scenario, which focused on optimizing housing supply while improving the housing standards of the lower social classes.

The *Urbanization Report* did not make a choice between these scenarios, but used them solely to guide short- and medium-term policy. The short-term policy should leave a certain flexibility, so that it does not exclude one of these four scenarios.

The differences in scenario aspects between the *Second* and *Third Report* are that in the later one several scenarios were created instead of just one. The previous descriptive, projective, and trend scenario was repeated, but also some normative, projective, and extreme scenarios were developed. No choice between scenarios was made, though in a sense each of these extreme scenarios may be a "common opinion" scenario.

2.4. *Formal Aspects of Scenarios*

A scenario has to be based on a set of consistent combinations of goals, policy measures, behavioral developments, and exogenous circumstances (Grassini 1982). This can be formally described as follows. Let us assume a set of goals $\boldsymbol{y} = \{y_1, \ldots, y_I\}$, of policy measures $\boldsymbol{v} = \{v_1, \ldots, v_J\}$, of behavioral variables $\boldsymbol{x} = \{x_1, \ldots, x_K\}$, and of exogenous circumstances $\boldsymbol{z} = \{z_1, \ldots, z_L\}$. Then a single scenario is a specific feasible combination of y_i, $\boldsymbol{v}$, $\boldsymbol{x}$, and $\boldsymbol{z}$, while a compound scenario has a nested structure that includes feasible and consistent combinations of single scenarios (thus including multiple goals). Figure 3 indicates the relationships between $\boldsymbol{y}$, $\boldsymbol{v}$, $\boldsymbol{x}$, and $\boldsymbol{z}$.

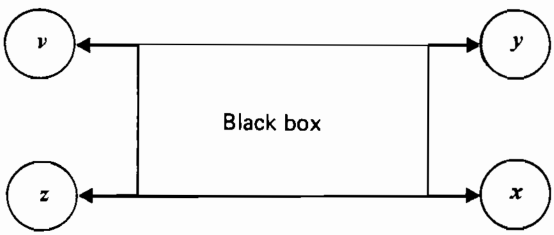

Figure 3 A formal picture of a compound scenario.

Clearly, the set $\boldsymbol{z}$ has to be predicted. If there is inadequate information, alternative future states of $\boldsymbol{z}$ may be postulated, and a scenario is then made up of a combination of alternative states of $\boldsymbol{v}$ and $\boldsymbol{z}$. Any consistent scenario has to take into account the structural relationships between $\boldsymbol{y}$, v, $\boldsymbol{x}$, and $\boldsymbol{z}$:

$$\boldsymbol{b}(\boldsymbol{y},\boldsymbol{v},\boldsymbol{x},\boldsymbol{z}) = 0 \; . \tag{1}$$

In the case of a compound scenario, several goal variables have to be dealt with simultaneously, so that essentially the following multiple-objective choice problem arises:

$$\max y = (y_1, \ldots, y_I) \; . \tag{2}$$

Together with the constraint set in (1), a compound scenario may thus be regarded as a feasible and efficient solution of a multiple-objective programming problem (see also Chapter 1). In this regard, an information system should also provide insight into the specification and estimation of the structural equations system, (1).

3. Qualitative Evaluation Methods

Conflict analysis is a basic part of regional urban planning because there are usually many actors, objectives, and levels involved in any choice problem. Multicriteria analysis has demonstrated its problem-solving capacity in regional and urban planning problems that are marked by conflicts emerging from the above-mentioned sources (e.g. Nijkamp 1980, Rietveld 1980, Spronk 1981, Nijkamp and Spronk 1981, Voogd 1983a).

Multicriteria analysis is a mode of thinking by which choice problems with conflicting options can be structured and rationalized. Normally, two elements are involved in the analysis: the assessment of impacts of policy measures for all relevant alternative choices; and the determination of sets of (political or societal) priorities.

Very often the impacts and priorities are hard to assess quantitatively. Therefore, qualitative (or "soft") multicriteria models, based on ordinal or nominal information, may offer a reasonable perspective. In this case, various methods may be employed in order to draw consistent inferences about the ranking of alternatives (plans, projects, policies, etc.). Only a brief survey will be given here. For more details the reader is referred to Nijkamp (1982) and Hinloopen *et al.* (1983).

3.1. *Expected Value Method*

The expected value method assumes ordinal information for both the impact matrix and the priorities (weights). The effects of all alternatives judged by a certain criterion j are ranked in descending order, while the preference scores or weights are conceived of as semiprobabilities, which are ranked in descending order of importance. Then, for each alternative i the ordinal impacts are multiplied with the corresponding ordinal preference scores or weights. The alternative with the highest total score will be selected as the best one, while all other alternatives may be ranked according to their "expected values" (Kahne 1975).

This method is essentially a rather crude weighted aggregation procedure based on nonpermissible numerical operations on ordinal numbers, so its use with qualitative information is questionable.

3.2. *Lexicographic Method*

The lexicographic method uses a classification of the evaluation criteria according to *a priori* defined importance classes. For each criterion j the impacts of all alternatives are also classified according to their degree of performance into *a priori* defined performance classes. Next, the alternatives are ranked by lexicographic ordering by means of a combination of the importance and performance classes (Holmes 1971).

This method is fairly simple and practical, although the identification of ordinal (or qualitative) equivalence categories is sometimes arbitrary. Then, ordinal multivariate classification procedures might be helpful.

3.3. *Frequency Method*

The frequency method is related to the lexicographic method and is also based on qualitative importance and performance classes. This method assigns the successive preference scores and criterion effects to *a priori* defined importance and performance classes, respectively. Next, one may construct compound importance–performance classes by a combinatorial analysis of the successive importance and performance categories. Finally, one may count for each alternative the number of times that it falls into a compound class. Clearly, an alternative falling often into a compound class characterized by a high performance and a high preference may be regarded as a promising candidate in the final rank order of alternatives (van Delft and Nijkamp 1977).

This method is also fairly simple and does not use nonpermissible numerical operations, although it may be sometimes difficult to infer unambiguous solutions.

3.4. *Ordinal Concordance Method*

The ordinal concordance method is an ordinal variant of the set of quantitative concordance (or Electre) methods. This method is based on a pairwise comparison of alternatives. Two indicators are calculated: the concordance index, an aggregate preference score for those criteria by which a certain alternative performs better than all others, and the discordance index, an aggregate discrepancy index for those judgment criteria by which a certain alternative produces worse results than all others. There is a wide range of ordinal concordance methods, characterized by their use of different concordance measures (depending *inter alia* on the use and specification of weights) (van Delft and Nijkamp 1977).

This method is fairly popular, especially in the French evaluation literature, although numerical problems may arise in the aggregation of ordinal scores during the pairwise comparison.

3.5. *Permutation Method*

The permutation method is also based on ordinal rankings of the information on impacts and weights. Its main emphasis is on the extent to which each alternative i supports the hypothesis that this alternative dominates all others. The method is based on a permutation of all possible rankings for all plans; it attempts to identify by means of a simultaneous analysis of weights and performances a certain ranking that is most probably in agreement with the above-mentioned hypothesis (Mastenbroek and Paelinck 1976).

This method uses a fairly complicated procedure, in which problems may emerge because of the large number of permutations, less comprehensible statements about probable rank orders of alternatives, and less clear interpretations of weights during the permutations.

3.6. *Metagame Method*

Metagame analysis can be interpreted as a specific game-theoretic method designed for qualitative (usually binary) information. This method is particularly relevant in the case of conflicting views among policy makers or judges evaluating alternatives. It is based on assigning a value of either zero or one to particular options in order to indicate whether or not an option will be accepted by the policy makers. Next, a combination and comparison of various options of the policy makers may lead to the identification of a compromise solution that is acceptable for all involved and that is marked by stability conditions according to a qualitative min–max criterion (Hipel *et al.* 1976).

A limitation of metagame analysis is that it is usually only based on binary information, so that no complete ordinal rankings are taken into account. In addition, the various steps of the compromise procedure are not always unambiguous.

3.7. *Eigenvalue Method*

The eigenvalue (or "prioritization") method is based on a matrix of pairwise comparisons of alternatives, which is constructed such that the matrix elements represent the dominance of one alternative over another with respect to a specific comparison criterion. Next, this priority problem may be transformed into an eigenvalue problem by means of ratios or weights, so that a vector of relative cardinal weights of the alternatives can be determined. This eigenvalue priority model is particularly suitable for deriving a cardinal judgment scale that may then be used in qualitative multicriteria analyses (Blair 1978).

The eigenvalue method is, strictly speaking, not an evaluation method; usually a complementary analysis is necessary. A drawback of this method is its uncritical interpretation and transformation of qualitative weights.

3.8. *Multidimensional Scaling Method*

The multidimensional scaling method is particularly appropriate for ordinal data problems. This method transforms ordinal data into cardinal data so that the new cardinal configuration agrees as much as possible with the initial ordinal rankings. A variant of this method can also be used to transform both the ordinal impact matrix and the ordinal weight vector into cardinal information, so that finally a set of quantitatively weighted results of alternatives is obtained. These results may allow a ranking of alternatives according to their aggregate performance.

The multidimensional scaling method is a fully operational method that uses no unpermitted mathematical operations on ordinal numbers. Drawbacks, however, may be its fairly complicated computational algorithm, and the sensitivity of the results to the initial configurations and to the number of dimensions chosen *a priori*. In addition, under certain circumstances no unambiguous conclusion can be drawn, as sometimes multiple rankings of alternatives are in agreement with the original ordinal data input (Voogd 1983a).

3.9. *Regime Method*

The regime method is a recently created qualitative multicriteria technique. The method was originally developed in the area of soft econometrics and categorical data analysis in order to take account of ordinal data in econometric models.

The essence of this approach is again a pairwise comparison of all alternatives by each criterion j. By assigning binary numbers to the results of the pairwise comparisons (according to whether a certain outcome is higher or lower than another), a long binary matrix of "regimes" is obtained. The same may also be done for the elements of the weight vector. From a combination of the information from both the regimes and the ordinal weights by a successive permutation procedure, the relative values of plans (i.e. the most likely ranking of alternatives) may be inferred (Nijkamp 1982).

This method, which has been tested in a few case studies, is a simple and easily comprehensible technique with many possibilities.

The provisional conclusion from this section is that information systems yielding only qualitative (ordinal or nominal) information are still important, as many methods exist that are able to take account of such information. They have found applications in many empirical regional planning problems in various countries.

4. Planning Control and Early Warning Systems

One of the main difficulties in designing information systems is that the planning process and the computer technology that supports it are evolving in a rapid and interdependent way. Therefore, it is unwise to design an information system exclusively for a given planning process; the planning process should also be oriented toward the new technology on which the information system is based.

Rosove (1967) identifies two main alternatives in designing an information system: design the system in one step; or design the system step-by-step, with each step more elaborate than the previous one. He also distinguishes between two different approaches:

The inductive approach: the technology of the existing information system is updated without changing the information system.

The deductive approach: the planning process is completely redesigned on the basis of its goals and opportunities for their achievement. For this approach the new information system should be developed.

If the information system is to be designed for a stable, simple, and closed system, the one-step, inductive approach would be sufficient. However, since "urban systems are notoriously dynamic, complex, and open, their aims and objectives are difficult to identify, they are difficult to analyze and their performance is difficult to evaluate, and they are managed by many people whose attitudes sometimes seem regressive in a time when change is inevitable" (Willis 1972, p.15), the iterative, deductive approach is more appropriate.

Rosove (1967) also suggests an iterative approach for the planning process, the first and simplest stage being an experimental model or prototype of the planning process to be designed. This approach needs a description of the planning process served by the information system. The planning process operates in a structure that can be considered as a network of arrows and nodes, as shown in Figure 4: the arrows represent the information channels and the nodes represent the decision points. The monitoring function, the policy design function, and the policy-testing function form the *planning control process*.

This planning control process has, among several other difficulties, to deal with a great amount and variety of uncertainty (see Section 1): uncertainty about societal values, and uncertainty about the effects of related decisions or about the environment and its future (Friend *et al.* 1970). To reduce these uncertainties one can use an *early warning system* (Dickey and Watts 1978).

At least four phases of an early warning system can be distinguished (Dickey and Watts 1978): (1) development of conceptual relationships; (2) collection of data; (3) screening and evaluation of the data; and (4) establishing of thresholds.

4.1. *Conceptual Relationships*

The first step is to make a rough selection of the data to eliminate redundant information – Ackoff (1967) indicates the risks of inefficient management caused by redundant information. Data can be selected by creating a conceptual model of the factors and relationships under study (Dickey and Watts 1978). If the major variables and their connections can be identified, the input data can be accepted or screened out according to their relevance to one or more of these factors or relationships. This can be achieved by the following procedure: consider the main inputs for the relationships between the variables; draw a graph of these (quantitative) relationships; make a more detailed description of these relationships, for instance by measuring them (if possible). The conceptual relationships can help to reduce the uncertainty about the effects of related decisions and about the future effects of the decisions that are taken.

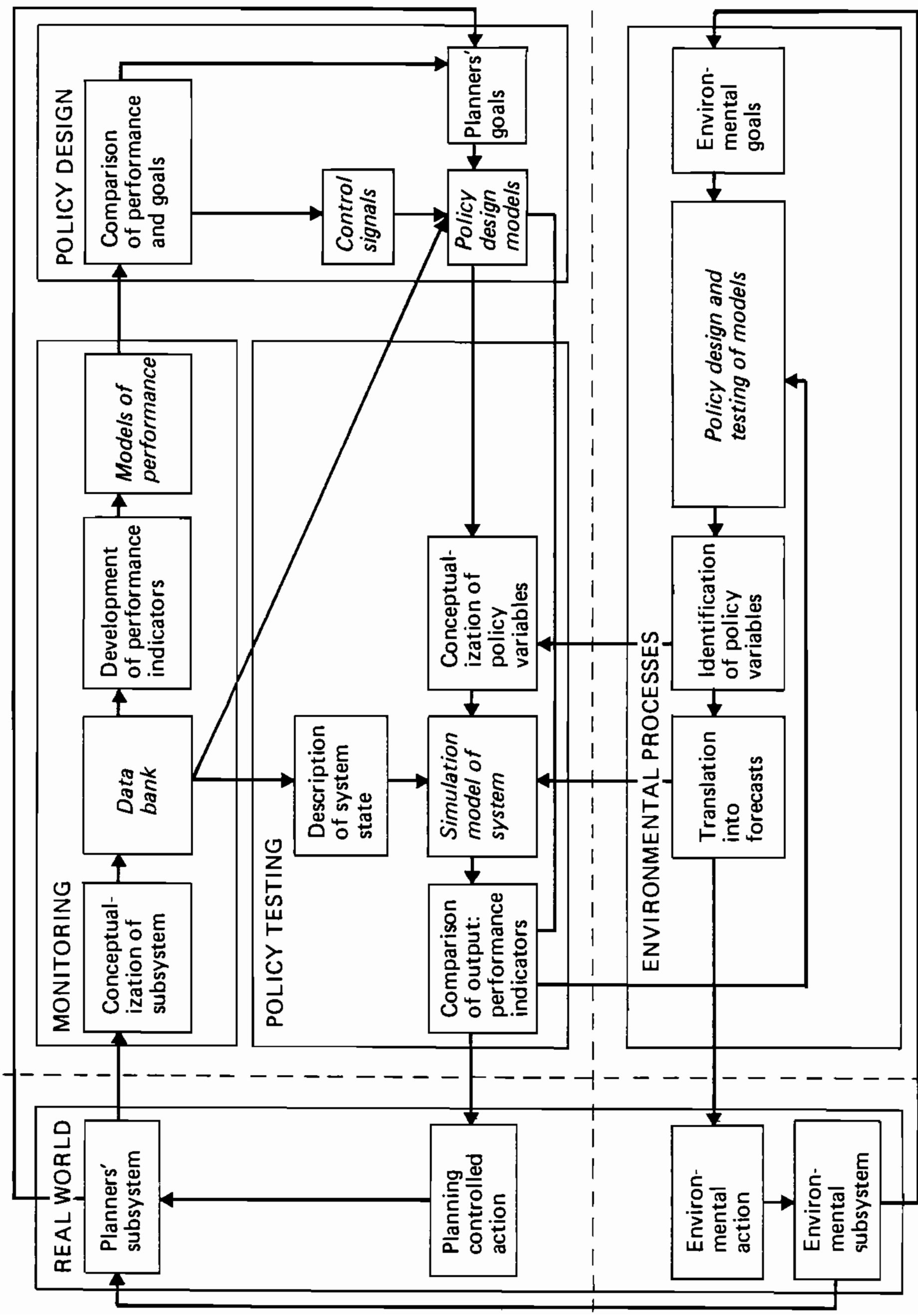

Figure 4 Model of a planning system (Willis 1972, p.17).

4.2. *Collection of Data*

Dickey and Watts (1978) distinguish next between three data sources that are relevant to an early warning system: experts in particular fields; the literature; and information systems.

4.2.1. *Discussion with experts*

At first a selection of experts is made, based on the field under study. They are consulted every two months and have to answer questions about the following subjects (Dickey 1976): recent changes in the area of concern; short-term trends; and long-term trends. They are also asked to give their opinions about the implications of possible future decisions. These views offer the possibility of reducing uncertainty about the environment, about societal values (recent changes), and about the future effects of decisions that are to be taken. Consultations every two months make it possible to adapt the planning control process rapidly and effectively to a new situation.

4.2.2. *Direct search of literature*

This can be regarded as a method of discovering developments and trends in parts of the field under study that do not lie at the center of discussion.

4.2.3. *Use of information systems*

Dickey (1976) suggests a broad information-gathering procedure that includes reading relevant journals, trade magazines, newspapers, etc. He advises placing emphasis on statistical information on past events, and short- and long-term forecasts and implications.

4.3. *Screening and Evaluation of Data*

The collected data should be listed at regular intervals to make a functional classification. From this list the redundant information can be screened out. At this stage the data can be evaluated. The results of the evaluation can be used to determine the implications of apparent trends and patterns, and to create short- and long-term projections in order to reduce the uncertainties about the effects of related decisions.

4.4. *Establishing Thresholds*

The aim of this phase is to find to what extent a change in a particular situation does not affect the attitudes of people concerned, especially experts and appointed officials. The threshold setting can be determined either by discussions with the persons involved, or by confronting these people with an actual decision situation and asking them whether actions are required in the near future or not (this may also be based on a retrospective investigation of time series).

These four phases constitute the early warning system. It is evident that several kinds of uncertainty can be treated by such a system, especially those with dynamic aspects (Voogd and Hamerslag 1981). Early warning systems were originally developed for small-scale or business problems but evidently have applications for the decision-making process in regional and urban planning as well. They are particularly useful for making process decisions.

5. Decision Support Systems

The increased use of computers has led to a shift in planning techniques for public policy making. However, the increase in man–computer interaction may lead to flaws in decision-making procedures because at some stages choices might be made on a more intuitive or opportunistic basis. In addition, the information provided by a computer cannot always be surveyed. Therefore, it is essential to pay attention to improvements in communication between users and analysts. In this respect, computer cartographic methods and decision support systems may be important in regional and urban planning. Clearly, this would also require an adjustment of planning theory to the potential of fast communications and interactions in planning problems. The development of microprocessor-based communication systems for transmission of information will no doubt affect the geographic distributions of economic activities and work places.

Although many decision aid systems used to be fairly rigid in their operations, procedures, and programs, there is nowadays a tendency toward more user-friendliness and flexibility (Fick and Sprague 1980, Bonczek *et al.* 1981). In particular, decision support systems appear to offer a rich potential (Ginzberg *et al* 1982).

In decision support systems it is assumed that the quality of a decision and the impact of its implementation are strongly determined by the relevance, nature, and quality of the information used. Decision support systems are, unlike management information systems, not especially built for daily routine or operating decisions, but for nonprogrammed choice problems, strategic decisions, or *ad hoc* problem-solving activities. Thus a decision support system may be defined as an automated information system for supporting strategic-level decision making in public administration, based on nonmachine interactions and designed to provide relevant information for less structured choice situations. Such a system may be useful in all stages of a planning problem: exploration, definition, design, generation of alternatives, evaluation, and selection. For each stage, a decision support system may concentrate on data collection, data transformation, and data presentation (Keen and Scott Morton 1978, Keen and Wagner 1979, Young 1983, Voogd 1983b).

A decision support system is particularly suitable for indicating the consequences of intuitive views or subjective considerations in semistructured judgment problems (Brookes 1981, Klein and Manteau 1983). Hence decision support systems may find the following important applications:

- retrieval of data on a selective basis
- transformation of rough data into condensed and structured information
- linkage of internal and external data bases
- use of models and statistical techniques for impact analysis
- use of heuristic problem-solving methods (e.g. methods based on artificial intelligence)
- inclusion of qualitative data or adaptive decision rules.

Decision support systems may be used in various choice and decision situations, such as design and scanning of survey data, compromise strategies in conflict analysis, generation of alternatives, scenario analysis, and econometric and statistical (qualitative and quantitative) impact modeling. Manola (1980) has listed the desirable features of an interactive decision support system: such a system should be able

- to construct reliable models for business decisions
- to retrieve data from a data base in an adequate manner
- to apply various types of special-purpose software packages in an efficient way
- to specify a user-oriented format of the output of an analysis or retrieval
- to identify for users the data and software tools that are available to solve semistructured problems
- to produce textual, numerical, and graphic output (charts, pictures, video displays, etc.)
- to provide a human-engineered computer interface for decision makers
- to monitor specified conditions and to signal their occurrence
- to provide access to other large data bases
- to provide effective communication facilities when there are several decision makers interacting
- to simulate results and effects in an efficient way.

Decision support systems may be used in a wide variety of management and policy problems in both private and public organizations (Dickson 1983). Their user-friendly nature may lead to improved decision making, an extension of intellectual capacity in the form of more nonprogrammed decisions, and a provision of agreement between achievable and desirable effects of decisions. According to Fox (1983) such a user orientation requires accessibility, extensibility, and consistency from an automated decision support system.

Several computer languages have been developed specifically for decision support systems, notably APL and PROLOG. APL is a very efficient language with brief codings, but is less user-friendly for nonexperts (Klein and Manteau 1983). PROLOG is more flexible and was designed in the area of artificial intelligence (Coelho 1983). It is especially powerful because of its extensibility (the ability of programs to adjust themselves to the user's desires).

Finally, it should be noted that the decision support system is a new tool in private and public planning problems. It has not yet reached full maturity, so one has to be cautious in judging its potential. Some flaws are: the user's dependence on techniques in making decisions, the potential abuse of decision support for the legitimation of predetermined decisions, the mechanization of public decision-making processes and the consequent decline in influence of informal interest and action groups, and the complexity of decision structures in public agencies.

Despite these limitations, decision support systems should result in improved decision making, since they may lead to a rationalization of complex choice problems, efficient use of all relevant quantitative and qualitative information, and rapid production of results in interactive strategic decision making in public institutions.

6. Conclusions

Information systems should increase the level of knowledge of phenomena in a planning and choice context. In the process mode of planning, adaptive information systems have to incorporate disaggregate information (even in a qualitative sense) on the objects of planning, especially regarding their medium- and long-term evolution. Consequently, the organizational and institutional framework of the planning process (including feedback mechanisms) has to be reflected in the design of information systems. This is one of the most serious faults in the design and use of information and monitoring systems. Several of the methods mentioned in this chapter are intended to cope with these faults, as they are based on the assumption that information systems have to provide insight into the complex, dynamic, qualitative, interactive, and often discordant nature of planning and policy problems. Structural uncertainty about future stages of a complex system can never be removed, but systematic analysis of (single and compound) images of an uncertain future aid the rationalization of choices for the future. Analogously, a systematic use of soft data and evaluation methods, of disaggregate monitoring and early warning systems, and of decision support systems may enhance the effectiveness and success of regional planning efforts.

References

Ackoff, R.L. (1967) Management misinformation systems. *Management Science* 14:147–156.

Blair, P.D. (1978) *Multiobjective Regional Energy Planning* (The Hague: Martinus Nijhoff).

Bonczek, R.H., C.H. Holsapple, and A.B. Whinston (1981)*Foundations of Decision Support Systems* (New York, NY: Academic Press).

Brookes, C.H.P. (1981) Incorporating text-based information within a DSS. DSS-81 *Transactions*, Proceedings of 1st International Conference on DSS, Atlanta, GA, pp. 86–107.

Coelho, H. (1983) PROLOG: A programming tool for logical domain modeling. *Processes and Tools for Decision Support*. Proceedings of Joint IFIP/IIASA Working Conference, International Institute for Applied Systems Analysis, Laxenburg, Austria, ed. H.G. Sol (Amsterdam: North-Holland), pp. 37–45.

van Delft, A., and P. Nijkamp (1977) *Multicriteria Analysis and Regional Decision Making* (The Hague: Martinus Nijhoff).

Dickey, J.W. (1976) A proposed early warning system for the Division of Motor Vehicles. *Technical Report* to the Virginia Division of Motor Vehicles, Virginia Tech., Blackburg, February.

Dickey, J.W., and T. Watts (1978) *Analytic Techniques in Urban and Regional Planning* (New York, NY: McGraw-Hill).

Dickson, G.W. (1983) Requisite functions for a management support facility. *Processes and Tools for Decision Support*. Proceedings of Joint IFIP/IIASA Working Conference, International Institute for Applied Systems Analysis, Laxenburg, Austria, ed. H.G.Sol (Amsterdam: North-Holland), pp. 155–164.

van Doorn, J., and F. van Vught (1981) *Nederland op Zoek naar Zijn Toekomst* (Utrecht; Antwerp: Het Spectrum).

Fick, G., and R.H. Sprague (eds.) (1980) *Decision Support Systems: Issues and Challenges*. IIASA Proceedings Series vol. 11 (Oxford: Pergamon).

Fox, M.S. (1983) The intelligent management system: An overview. *Processes and Tools for Decision Support*. Proceedings of Joint IFIP/IIASA Working Conference, International Institute for Applied Systems Analysis, Laxenburg, Austria, ed. H.G.Sol (Amsterdam: North-Holland), pp. 105–130.

Friend, J.K., and W.N Jessop (1969) *Local Government and Strategic Choice* (London: Tavistock).

Friend, J.K., W.N. Jessop, and J.M. Power (1970) The LOGIMP experiment: A collaborative exercise in the application of a new approach to local planning problems. *Information Paper* 25, Centre for Environmental Studies, London.

Friend, J.K., J.M. Power, and C.J.L. Yewlett (1974) *Public Planning: The Intercorporate Dimension* (London: Tavistock).

Ginzberg, M.J., W. Reitman, and E.A. Sohr (eds.) (1982) *Decision Support Systems* (Amsterdam: North-Holland).

Grassini, M. (1982) A natural scenario for a regional model. *Working Paper* WP-82-131, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Hinloopen, E., P. Nijkamp, and P. Rietveld (1983) Analysis of conflicts and compromises using qualitative data. *Regional Science and Urban Economics* 13(1):77–102.

Hipel, K.W., R.K. Ragade, and T.E. Unny (1976) Political resolution of environmental conflicts. *Water Resources Bulletin* 12(4):813–827.

Holmes, J.C. (1971) An ordinal method of evaluation. *Urban Studies* 9:179–191.

Kahn, H., and A.J. Wiener (1967) *The Year 2000, A Framework for Speculation on the Next Thirty-Three Years* (New York, NY: Macmillan).

Kahne, S. (1975) A contribution to decision making in environmental design. *Proceedings of IEEE Conference on Cybernetics and Society* (Cambridge, MA: IEEE), pp. 518–528.

Keen, P.G.W., and M.S. Scott Morton (1978) *Decision Support Systems: An Organizational Perspective* (Reading, MA: Addison-Wesley).

Keen, P.G.W., and G.R. Wagner (1979) DSS: An executive mind-support system. *Datamation* November, pp. 117–122.

Klein, M., and A. Manteau (1983) OPTRANS: A tool for implementation of decision support centers. *Processes and Tools for Decision Support*. Proceedings of Joint IFIP/IIASA Working Conference, International Institute for Applied Systems Analysis, Laxenburg, Austria, ed. H.G. Sol (Amsterdam: North-Holland) pp. 165–187.

Manola, F.A. (1980) Database technology in decision support systems: An overview. *Decision Support Systems: Issues and Challenges*, eds. G. Fick and R.H. Sprague. IIASA Proceedings Series vol. 11 (Oxford: Pergamon), pp. 69–93.

Mastenbroek, A.P., and J. Paelinck (1976) Multiple-criteria decision making, information exhaustion, uncertainties and nonlinearities. Unpublished paper, Netherlands Economic Institute, Rotterdam.

Nijkamp, P. (1980) *Environmental Policy Analysis* (Chichester; New York, NY: Wiley).

Nijkamp, P. (1982) Soft multicriteria analysis as a tool in urban land-use planning. *Environment and Planning* B 9:197–208.

Nijkamp, P., and J. Spronk (1981) *Multicriteria Analysis: Operational Methods* (Aldershot: Gower).

Rietveld, P. (1980) *Multiple-Objective Decision Methods and Regional Planning* (Amsterdam: North-Holland).

Rizzi, M. (1982) Plausibility relations and multiple expected utilities in decision making under uncertainty. Unpublished paper, LAMSADE, University of Paris – Dauphine.

Rosove, P.E. (1967) *Developing Computer-Based Information Systems* (New York, NY: Wiley).

Spronk, J. (1981) *Interactive Multiple Goal Planning for Capital Budgeting and Financial Planning* (Boston, MA; The Hague: Kluwer Nijhoff).

Verbaan, A.A., H. Leeflang, and A.A. Verduijn (1982) Perspectieven in de ruimtelijke ordening. *Report*, Rijksplanologische Dienst, Staatsuitgeverij, The Hague.

Voogd, H. (1983a) *Multicriteria Evaluation for Urban and Regional Planning* (London: Pion).

Voogd, H. (1983b) Decision support systems voor overheidsplanning. *Research Paper* 1983-4, Department of Civil Engineering, Delft University of Technology, Delft.

Voogd, H., and R. Hamerslag (1981) Early warning system for process keeping. *Nieuwe Tendensen in de Vervoersplanologie*, eds. J. van Est *et al.* (The Hague: Colloquium Vervoersplanologisch Speurwerk), pp. 511–528.

Willis, J. (1972) Design issues for urban and regional information systems. *Working Paper* 71, Centre for Environmental Studies, London.

Young, L.F. (1983) Computer support for creative decision-making: Right-brained DSS. *Processes and Tools for Decision Support*. Proceedings of Joint IFIP/IIASA Working Conference, International Institute for Applied Systems Analysis, Laxenburg, Austria, ed. H.G. Sol (Amsterdam: North-Holland), pp. 47–64.

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CHAPTER 7

Regional Information Systems in Centrally Planned Economies

P. Dujnic, B. Issaev, † and **D. Slimak**

1. Characteristics of Regional Development Planning in A Planned Economy

In countries with planned economies the understanding about the value of space in planning social and economic development has been based on economic theory, and on the principle that all social phenomena have a common purpose: to achieve a higher material and cultural level for the whole population. Economic theory thus underlies the unification of the sectoral and spatial aspects of production as well as the allocation of common work to different sectors and areas. In this way it is recognized that regions are systems with differentiated structures, and that their relationships are the source of contradictory tendencies under the conditions of a planned economy.

In countries with highly concentrated economic activities and intensively utilized territory, the regional conditions themselves influence the formation of a rational sectoral structure within the national economic framework. Conversely, the development of regions is determined not only by regional needs but also by the character of the national system or of a supranational economic configuration, such as the Council for Mutual Economic Assistance. The planning of regional development is thus not an isolated activity but constitutes part of the national economic plan. This plan decisively regulates the entire production process and determines the development of and relationships among regions.

The regional aspects of the national economic plan are implemented through rational distribution of productive forces, economic activities, and physical funds so that:

- standards of living in regions with different social and natural conditions are balanced with each other (the criterion of social equilibrium);
- natural and economic resources are rationally utilized for an efficient development of the whole national economy, and the optimum conditions for economic activities are fulfilled (the criterion of economic equilibrium); and
- natural and man-made conditions are balanced and an optimum living environment is created (the criterion of ecological equilibrium).

The criterion of social equilibrium expresses the basic social and political aims of the society, that is, the desirable organization of social structure (e.g. by sex, nationality, and profession) or the desirable changes in life-style and the conditions under which these changes can take place. The aims of social development in individual regions are derived from the requirement to create social equilibrium among regions. These aims are expressed in the form of prospective standards of living. The criterion of social equilibrium applies to the long term and hence defines the limits to the allowable consequences of applying the other two criteria.

The criterion of economic equilibrium expresses both the main strategic and short-term economic aims of regions and the conditions for interregional integration. The criterion can also be expressed synthetically in the form of regional economic profiles (economic functions). The aims of the economic development of a region cannot be derived solely from an isolated set of internal conditions, in spite of their undoubted significance, since these may accelerate or restrict the formation of the economic profile. Because regional economic activities occur in economic systems that are not limited regionally, the profile (production function) can be specified only within the context of economic sectors, the economy of the state, and the supranational economic system.

The economic profile (economic function) of a region specifies how the economic activities in various sectors should interact in order to realize the potential of production, using the common productive, technical, and social infrastructure.

The criterion of ecological equilibrium reflects the society's aims for developing and protecting the living environment. The exploitation of land in a number of regions causes criticism about the quality of the environment. If the ecological equilibrium is to be preserved, expensive measures must be taken. To apply this criterion, limits to the development or structure of the economic base and density of population are specified.

These three proportionality criteria decide each region's share of the overall economic structure and must be applied when planning the development of different sectors, when considering interregional relationships, and when planning the development and internal organization of individual regions that are functionally differentiated. Therefore, it would be logical if, in the majority of countries, regional planning were introduced in addition to territorial (i.e. local or intraregional) planning, which has been the traditional means of implementing communal policy. At present, regional and territorial planning is used by the state for regulation and coordination of economic units organized according to sectors. Coordination within the regional economic and spatiotechnical framework may be characterized as a subsystem of the unified planning and management system of the society.

Within this system, regional planning has the following functions:

- to evaluate the economic and social levels of each region;
- to specify the development of basic functions in each region according to its particular resources and conditions;
- to provide economic and social balance in the organization of the production and nonproduction sectors and to regulate the development of dwellings;
- to regulate the distribution of individual production sectors and activities to ensure the efficiency of territorial specialization, cooperation, and management of production;
- to ensure that labor resources and shortages are balanced, especially with respect to profession, age, and sex, and that population migration is regulated.

Territorial planning has the following tasks:

- to specify the functions of each territory, determine its optimum organization, and set the principles for its long-term development;
- to specify areas for individual economic and social schemes, and to describe how these schemes should be realized;
- to specify any necessary decontamination, recultivation, or reconstruction and to specify how the territory is to be protected;
- to specify where services should be located and to establish principles of town planning according to which projects should be carried out;
- to suggest rules for coordinating construction, with respect to the type of construction and construction priorities.

Regional planning plays the more significant role in the solution of interregional relationships and in the specification of the economic functions of regions, while territorial planning is more concerned with the organization of the internal functioning of regions and with the organization of town planning from the point of view of dwelling units.

The different functions of these two levels of planning are reflected in their institutional organization. The central bodies of the state administration (the central planning bodies, ministries, and top local authorities of regions or areas) are responsible for regional planning, while territorial authorities of the state administration are responsible for local planning.

Despite the creation of appropriate methodological, legislative, and institutional conditions for managing regional development, comprehensiveness in planning activities has remained the crucial problem. The increasing complexity of the managed object on the one hand and the level of current technology and methods employed in planning and decision making on the other hand make it difficult for economic practice to overcome the "resistance" of some factors that retard regional and territorial planning.

One such factor is the acceleration of technical progress, which makes the innovation cycle shorter in the majority of sectors. The period for which a set of sectoral goals is defined, and which is needed for the evaluation of their effect upon regional development, is necessarily reduced. During the development of long-term regional and territorial plans, this fact is manifested as a lack of information about the development of a given sector. There is a tendency to prolong the period of the planning forecast, which results in a negative attitude from the sectoral authorities, and the data obtained in this way have little value for long-term planning. Long-term regional and territorial plans supported by such information lose their basic conceptual character that would guarantee the comprehensiveness of decisions on localization of economic activities, and therefore the expected efficiency of territorial planning is reduced.

Attempts have been made to solve this problem by changing the methodological approach to long-term planning as well as by changing the technology and methods of decision making. While the first solution underlines the tendency of planning support data to vary, the second suggests that new methods should be introduced into decision making. Methods that imitate planning support activities would, after a short time, make it possible to evaluate the effect of local goals upon interregional social and economic relationships and upon the future social structure and economic base of a region.

Since 40–45% of activities performed during the development of regional and territorial plans (and as many as 70% in the preparation of decisions) involve collection and processing of information, it becomes clear that more progressive approaches to planning require more rational and efficient handling of information. This could be done by means of a data base that would make possible rapid processing of relevant information that has previously not been standardized in most cases.

Regional and territorial planning, as an interdisciplinary activity, requires the cooperation of a large number of research and planning organizations and state administrations. The complexity of this cooperation is multiplied particularly by the organizational and territorial dispersion of decision-making activities. Despite the fact that their links with one another are specified by legislative standards and methodological measures taken by the central authorities, the technology of their interaction has not yet been developed so that all relevant information can be exchanged within the necessary time scale.

Since a comprehensive system cannot be created by a simple concentration of decision-making activities, one has to search for the solution in the methods of information processing and in the organization of information flow, by integrating information systems and by supplying information in a better way. More comprehensive decision making thus requires substantial, qualitative changes in data-processing technology.

2. Some Problems in the Development of Regional Information Systems

Although regional and territorial planning in the majority of countries with centrally planned economies is carried out by relatively autonomous management systems, its success depends upon the interaction and achievement of higher integration of these systems. The interaction of regional and territorial planning activities, as well as their links with management systems of individual sectors, takes the form of information exchange. Planning-oriented information systems are the best means of integration. The long-term aims, therefore, must be the creation and application of an integrated information system for the planning and management of both regional and territorial development. However, a lot of methodological and technological problems must be solved in the process. A few of them will be discussed here.

2.1. *Unification and Utilization of Data Sources*

The data necessary for processing the planning-oriented information itself are typically obtained mostly from external sources. The planning system itself produces data on the planned development of the region and on the arrangement of its settlement structure. Other data, describing the natural, economic, social, and technical conditions of a region, are of the character of external data and are distributed in methodologically heterogeneous sectoral information systems. The process of acquiring external (primary) data is influenced by the heterogeneity of data base content, the number of organizationally independent data sources and users, and the spatial dispersion of these sources and users.

2.1.1. Heterogeneity of data base content

The basic problem in the development of a regional information system is the creation of methodological, organizational, and technical tools that allow data flow from sectoral information systems, and the construction of a homogeneous data base. The apparently simple solution is to collect, for individual planning bodies, the required data stored in the sectoral information systems. Thus, by a transformation of content and form, relevant aggregated information can be created *ad hoc*. Such approaches are applied on a large scale in present-day planning and management.

From the point of view of applying more effective methods of regional planning and management, such an approach has several problems:

- extra work is created for some individuals in data collection and processing;
- continuous updating of files cannot be ensured in practice;
- files are not created sufficiently promptly to suit the users' changing needs;
- the successful use of aggregated data on a broader scale cannot be ensured because the rules of data transformation, with respect to content and form, are often unknown;
- transformation and transfer of data from sectoral information systems for a narrow circle of users is laborious and expensive.

The basic presumption behind the creation of a uniform data base is the utilization of the information networks of the individual sectors. Special methods, such as coding, facilitate the transformation and transfer of data from these networks into the data base of the regional information system. However, the use of classification and coding systems as data converters has a lot of disadvantages. For example, these systems are constructed to perform a particular classification of the phenomena under review. If these phenomena undergo quick changes, their stability is affected and since the coding system functions as a converter, the assumed information flow is interrupted.

Another problem, which is a frequent source of error, is that the arrangement of phenomena in a particular classification in the regional information system has to be carried out by reporting units in the individual sectors. These units may operate by different criteria. If there is a great number of reporting units and if there are ambiguous interpretations of the contents of the classification systems, an inaccurate and incorrect arrangement of information takes place, and thus the integrative and methodological properties of the data base are weakened.

The data links between the regional information system and the sectoral information systems can be stabilized by matching the variables characterizing the natural, technical, economic, and social conditions with identifiable elements in the sectoral and regional complexes. For natural and technical conditions this is no problem, because the common elements are localized, and their locations can be identified in the sectoral accounting system as well.

A more complicated theoretical and practical problem is the determination of common elements in economic and social phenomena. Social and economic processes are connected with organizational structure and characterized by indicators that have no spatial features. However, it is possible to identify elements of these processes that represent individual social and economic activities. These elements can now be identified by means of planning-oriented facilities and locally detached performance units (LDPU), ranging from a whole plant to a work unit. Planning-oriented facilities may thus be represented by variables expressing the state and dynamics of social and economic processes. The base of common elements thus created makes it possible to unify the sectoral and spatial aspects in the planning of production. Permanent identification numbers are assigned to individual LDPUs to allow the transfer of data between the sectoral information systems and the regional information system.

The practicability of this method is proved by the efforts of several countries with centrally planned economies (e.g. Czechoslovakia, Hungary, and the German Democratic Republic), which have already created LDPU registers. The main problem is to define an LDPU in such a way that it can be applied to all sectoral systems. It has also become evident that the creation and maintenance of LDPU registers is laborious and expensive, especially if they are only used by a small number of people. It is, therefore, necessary to broaden the social usefulness of such a tool.

2.1.2. Spatial and organizational dispersion of data sources and users

Since a regional information system will be constructed in an inhomogeneous organizational environment, an important problem to overcome is the spatial and organizational dispersion of the data sources and users (Figure 1). At the same time, several user requirements should be met:

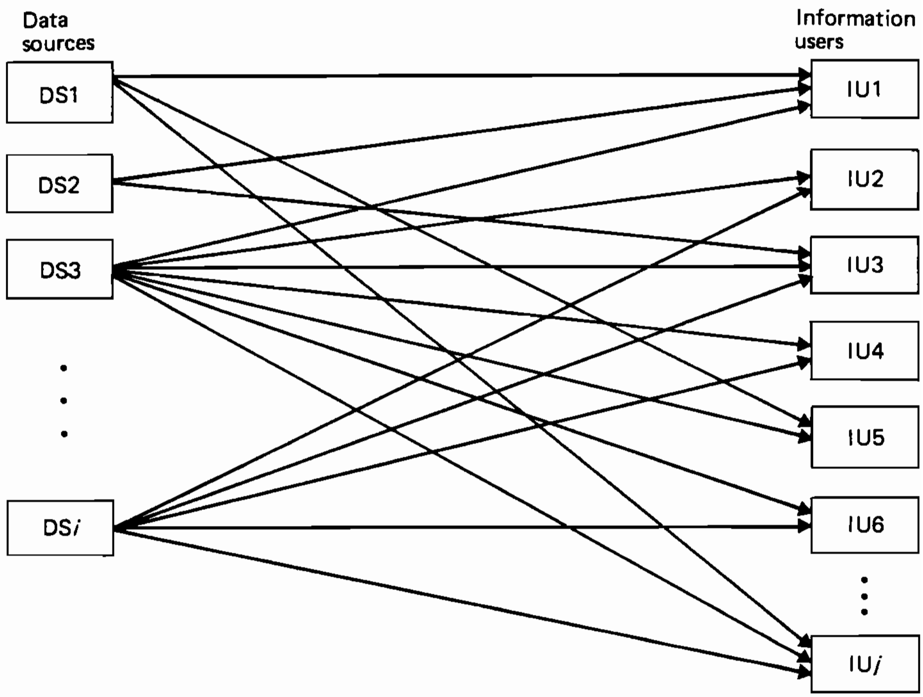

Figure 1 Spatial and organizational dispersion of data sources and users. Characteristics: causal connections and information rustle.

- to create and supply only the information that is necessary for the particular planning activity, the information having a form adequate for the techniques used in planning and decision making;
- to increase the user's certainty of information retrieval by ensuring the stability of the information channels;
- to shorten the time between the demand and the supply of information.

The solution of a problem depends upon the choice of organizational means and technical tools by which primary data will be collected, as well as upon the concentration of data in the available data base and the processing and delivery of information.

Fulfillment of the above-mentioned demands entails, first of all, compression of the information array and the creation of permanent information channels that would, in the case of a great number of information sources and users, exclude the present causal connections. Data concentrators would also be needed as basic organizational units between the users and the sources. Their functions would be:

- to maintain permanent connections with the data sources (or to seek new data sources);
- to ensure the extraction of data from external (sectoral) sources;
- to create a standard primary data base for the regional information system;
- to present information about the contents and structure of the primary data base or about the users ("metainformation system");
- to select data according to the users' requirements and to ensure their transfer into regional and territorial planning-oriented data bases.

Even with data concentrators the problem of transforming data is not yet solved, unless the user can make his own interpretation of the available data. The transformation of data into planning-oriented information depends on the user acquiring skills in computer techniques. Although an ideal state of automation will probably never be achieved, work connected with data analysis and information creation must, from the point of view of organization as well as location, be brought nearer to the user. When there are many users it is possible to apply this principle only by introducing distributors, in the form of territorially organized planning-oriented data bases, into the data flow (Figure 2).

To observe the principle of integration under a planned economy, the regional information system must be organized as a unified national system with data concentrators and planning-oriented data bases in the central bodies as well as in the regional or local planning bodies.

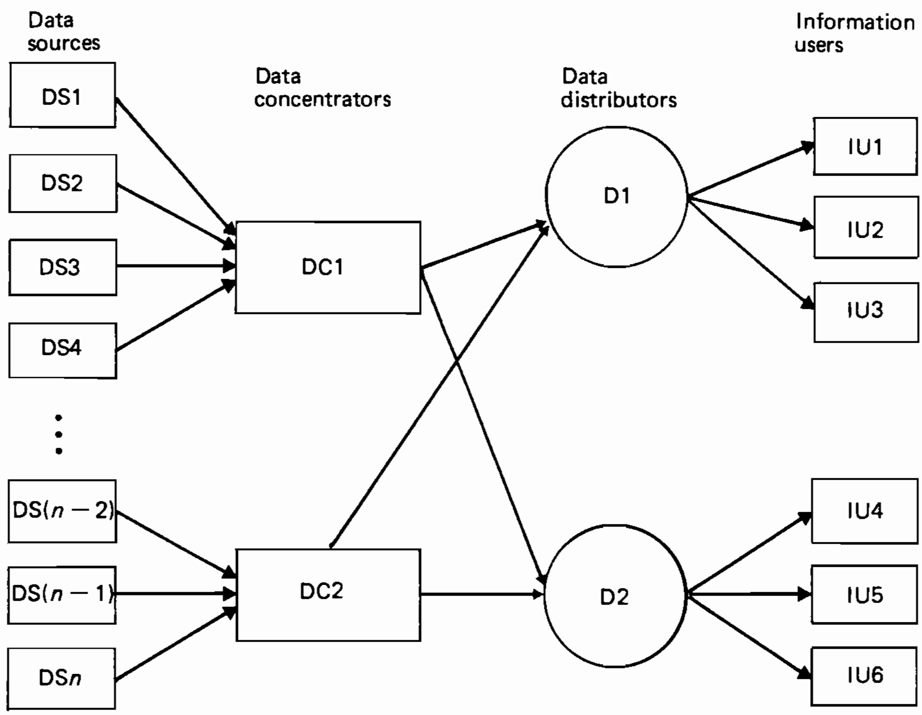

Figure 2 Hierarchy of sources and users. Characteristics: stable information channels, certainty of obtaining information, initial information rustle, and automation of data processing.

2.2. *Structuring Demand and Provision of Information*

Demand for information is characterized by content, time, goal, subject, and type of user. In practice, only those parts of information systems that are associated with standard and administratively regulated procedures of planning are well adapted to this demand structure. In addition, if long-term development of a regional system is considered, "slow" components of the system become more important; examples are the changing potential of natural resources, long demographic waves, ecological changes, shifts in technology, and fundamental changes in national and supranational systems. As a rule, these components are not covered by the traditional information systems of national planning and statistical services. They may be the subjects of specialized systems, but there is then a problem of how to use the information in the context of comprehensive socioeconomic analysis and planning. As for the time dimension, regional information systems concentrate on the short term or, to a lesser extent, the medium term. Existing information systems also do not have a sufficient regional orientation; sectoral and national views are predominant. Planners, economists, and information analysts in socialist countries are examining how information systems can be made flexible and diversified enough to respond to changing structures of information demand, or even of management, and how to complete them with information on changes in "slow" variables. Qualitative information, information on objectives, and issues of uncertainty are among the topics of discussion.

The elements of the matrix in Figure 3 show the most important logical links for a planning-oriented information system.

			Planning and management						Real systems					
									Stocks			Flows		
			1 Short-term	2 Medium-term	3 Long-term	4 National	5 Regional	6 Local	7 Nature	8 Man	9 Technology	10 Changes in resources	11 Economic activities	12 Social and demographic changes
Planning and management		Short-term 1												
		Medium-term 2	2.1											
		Long-term 3		3.2										
		National 4	4.1	4.2	4.3									
		Regional 5	5.1	5.2	5.3	5.4								
		Local 6	6.1				6.5							
Real systems	Stocks	Nature 7		7.2	7.3	7.4	7.5							
		Man 8		8.2	8.3	8.4	8.5	8.6						
		Technology 9		9.2	9.3	9.4	9.5	9.6	9.7					
	Flows	Changes in resources 10		10.2	10.3	10.4	10.5		10.7					
		Economic activities 11	11.1	11.2	11.3	11.4	11.5	11.6	11.7		11.9			
		Social and demographic changes 12	12.1	12.2	12.3	12.4	12.5	12.6		12.8	12.9		12.11	

Figure 3 Links for planning-oriented information systems.

Long-term planning of regional development is a prerogative of two levels of decision making, national (4.3) and regional (5.3). The information system should ensure coordination between these levels (5.4). The regional level also needs coordination with the subregional level (6.5). Of crucial importance for long-term planning is information about stocks of slow components of the regional system, such as climatic conditions, the biological potential of the territory, mineral and other natural resources

(7.3), population and its structure (8.3), the technical and social infrastructure, and the stock of capital (9.3). This information should also be linked with medium-term planning (7.2, 8.2, 9.2) and delivered, in the form of integrated medium–long-term models, to national (7.4, 8.4, 9.4) and regional (7.5, 8.5, 9.5) planners.

For long-term planning and forecasting at the regional level the concept of flows is highly important for integrated analysis, since it introduces linkages between elements (nodes) and allows the representation of the regional system as an oriented Euler graph, with its high potential for analysis of systems with essential feedbacks. Traditionally, this form of information covers economic activities (flows of goods and income) and some demographic activities (migratory phenomena). Two additional areas of flow information are required: changes in the regional potential in mineral and other natural resources, and changes in the main elements of social and demographic structure. These linkages are marked in the matrix by elements 10.2, 11.2, 12.2 and 10.3, 11.3, 12.3. Information on flows of natural resources, goods, income, and capital should be presented for use in planning in such a form that medium- and long-term aspects are linked together.

Short-term planning and operational management now generate most demand for information. These needs are not isolated from medium-term requirements (2.1), as they exist at all three levels of planning (4.1, 5.1, 6.1). The information content for short-term planning covers mainly current economic activities (production and use of social products, consumption, capital formation, market activities, prices, distribution and redistribution of incomes) and short-term changes in the social and demographic spheres (migration, employment, education, social services, social capital, etc.). But short-term planning-oriented information systems should also be consistent with medium- and long-term economic and sociodemographic processes (11.2, 11.3 and 12.2, 12.3). Users at different levels of planning (10.4 to 12.6) should be supplied with integrated information in which processes with different time horizons are linked together. This is essential for the proper representation of the different dynamics of the elements of a regional system.

Matrix elements 10.7, 11.7, 11.9, and 12.9 represent situations where integrated accounting principles linking stocks of resources (column 7) and capital (column 9) with economic and social flows are warranted for planning purposes. Social accounting should also be linked with accounting for economic flows (12.8).

This simplified scheme gives grounds for some observations on the methodology relevant to adjusting the development of regional information systems to the needs of long-term regional planning.

(1) In order to relate information systems to the real regional system (rows and columns 7–12) it is important to apply a phenomenological approach and to emphasize the interdependences between elements of the real system in terms of their stocks and flows.

(2) The completeness of the description of the system, including its diverse character and dynamic properties, is of crucial importance in improving regional information systems.

(3) To relate information systems to planning there should be selected goal-oriented spectra of information on links between stocks and flows to satisfy the needs of local, regional, and national decision makers.

(4) The organization of planning activities, the distribution of responsibilities between national, regional, and local authorities, and the formulation of goals cannot be considered as entirely exogenous for the development of information systems. They evolve with an increasing degree of understanding of the real system. Thus, there is a two-way relationship between planning and information.

2.3. *Information Systems for Integrated Planning*

An extremely important function of information systems, with respect to planning and decision making, is integration. Irrespective of whether the plan is a set of coordinated projections for various aspects of the socioeconomic system, it is essential that the results of all decisions are consistent in the real system. If an information system is well organized, even isolated decisions can be checked for consistency.

Although the modeling of causal relations between the components of the system in question constitutes the main tool for integrated analysis and decision making, much more could be achieved, especially where models are not involved in the planning procedure. The principles and techniques of integration should be applied to reflect reality and to relate information systems to these models, as well as to goal-oriented planning activities.

Accounting principles seem to offer a promising way of standardizing the organization of information (classification, algorithms of aggregation–disaggregation, identification of primary data, information output, etc.). If a system component has properties that allow it to be changed over time, or to be transferred from one agent to another or from one agent in one function to the same agent in another function, the value of this component can be represented by a flow (or edge) linking two nodes. The introduction of this approach by definition makes the image of the socioeconomic system closed. Whatever the interpretation of the nodes and edges might be, no flow can appear in the system from "nothing" or disappear without generating other flows that result in the same total value. In this system, to which accounting principles are applied, the information is balanced at each node, for which the sum of the incoming edges is equal to the sum of the outgoing ones. There always exists a circuit of edges linking any node with any other.

Accounting principles are widely applied in statistics to describe socioeconomic activities. However, their application to demography (e.g. to changes in the social, educational, professional, and occupational structure of a population) is more limited; they are even less applicable to natural resources. It would be advisable not only to apply them to regional information systems, to reflect changing stocks and different intensities of flows of resources, capital, people, products, income, and liquid assets, but also to find ways of linking these separate accounting systems to form a complete representation of a regional system (Figure 4).

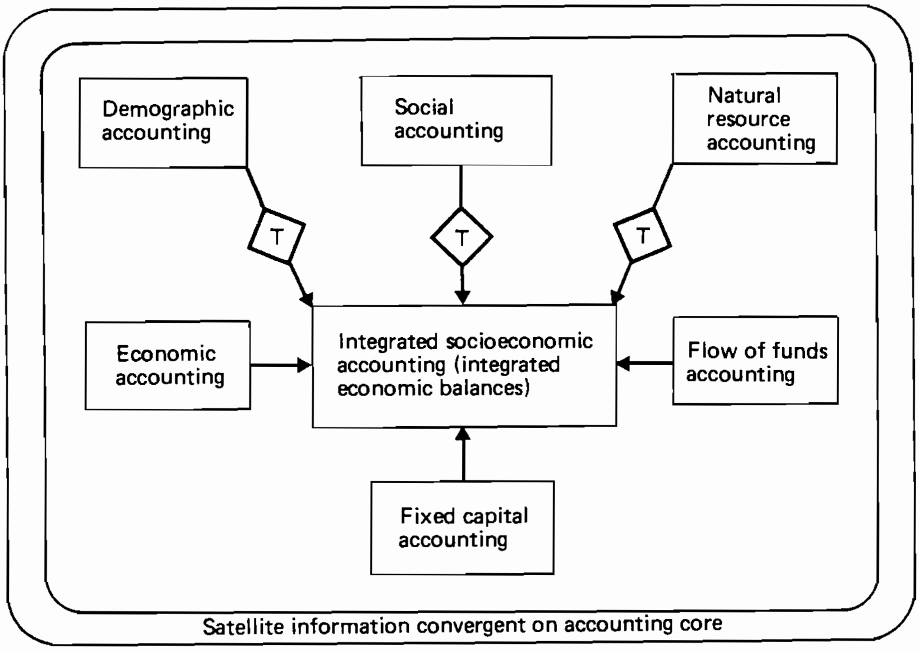

Figure 4 Accounting frame for planning-oriented information systems. T: transition procedure.

Some experience in representing an integrated economic balance in matrix form for analysis of the response of a system to changes in sets of variables was gained at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria as a result of a case study on regional development in Tuscany, Italy (Issaev and Umnov 1982). A matrix of integrated economic balance for Tuscany acts as a common data base for specific models and through which models communicate with each other.

In principle, primary data for the realization of a comprehensive accounting system exist (at least in the USSR), but they are dispersed over decentralized agencies. The actual problem consists of linking specialized accounting schemes to the core system, which will require the introduction of transition procedures (T in Figure 4).

2.4. *Planning Methods in the Regional Information System*

One of the biggest drawbacks in the proper use of information systems is the lack of methods for rationalizing the planning and decision-making processes. Experience in many countries indicates that without a parallel development of analytic methods and programs to aid planning and decision making, the data base becomes a deposit of "dead" data.

Another problem is that planning support given to the regional information system is mainly task-oriented, and models are not much used for processing data. In addition, information systems usually deliver standardized planning or reporting documents as a result of "direct calculations." Behind these calculations are more or less complicated formulas and corresponding algorithms, but no feedbacks or formalized methods for making choices exist.

Nevertheless, models are introduced into information systems for individual tasks. The most widely used are dynamic versions of input–output models, although the respective tables and projections are not part of the official documentation of plans and there is no direct correspondence between the net-branches of input–output tables and the real sectors for which plans are established. In some cases, where republican planning authorities, together with scientific institutions, have developed systems of models as auxiliary tools to support *ad hoc* management, data bases for these systems enter into the republican information systems. Such are the cases in the Baltic Republics and the Kazakh Republic of the USSR, where systems of models based on the combination of input–output techniques for flows of goods and econometric analysis for flows of income have been developed and implemented. However, these practices are not included in the official regulations on planning procedures.

An elaborate, well structured system of planning-oriented models and a data base have been developed for the area around the Baikal–Amur railway. There are also data bases for the main systems of models used in the USSR for reconciliation of sectoral and territorial approaches in planning (Baranov and Matlin 1981) and for multiregional input–output simulation and optimization models (Granberg 1982). However, these *ad hoc* data bases have no permanent function in regional planning. Models find larger applications in sectoral computerized information systems at the national and regional levels than in the territorial republican automated management systems. Extrapolation and simulation models predominate; the share of optimizing models does not exceed 3% (Fedorenko 1982).

The inclusion of models as a "bank of methods" (Section 3.3) in socioeconomic information systems is one of the most important strategic goals in the development of information systems for regional planning. According to Bandman (1981) the set of models required for long-term planning of a large and diversified territorial productive complex (TPC) should include:

- models of the spatial distribution of the TPCs within a region;
- models for projection of the basic parameters of TPCs;
- models of the spatial and productive structure of each TPC;
- models for choice of location of plants;
- models for specific occupational–residential nodes;
- models for the use of land and natural resources, of the productive and social infrastructure, and of labor resources for each TPC;
- a comprehensive planning model for each TPC.

This set of models has been tested while planning a TPC in the Angara–Yenisei region of Siberia.

3. A Possible Design for an Integrated Information System for the Management of Regional Development

Having specified the requirements for a regional information system in the preceding sections, and drawing on experience gained in creating automated information systems in centrally planned economies, we shall now outline a plausible design for such a system. The scheme in Figure 5 shows the functional, and partly technological, characteristics of the system. Technical and organizational problems in developing and implementing the system are not considered here, though the application of up-to-date techniques and technology is implied.

3.1. *External Data Sources*

In the sphere of information arising out of the process of managing economic and social development, three basic information systems are distinguished:

- a system of socioeconomic information, comprising the data serving to identify the state and patterns of development of society;
- a system of plan information, including the information arising from the process of plan creation, as well as information pertaining to projects, forecasts, drafts of the plan, and state budget proposals;
- a system of scientific, technical, and economic information.

Apart from these basic information systems, purpose-oriented information systems are created. Depending on the users' needs, these systems comprise sets of information taken from the basic systems or from other sources. The integrated regional information system is a typical purpose-oriented information system. Its major sources are sectoral information systems, information systems of central planning bodies, statistical

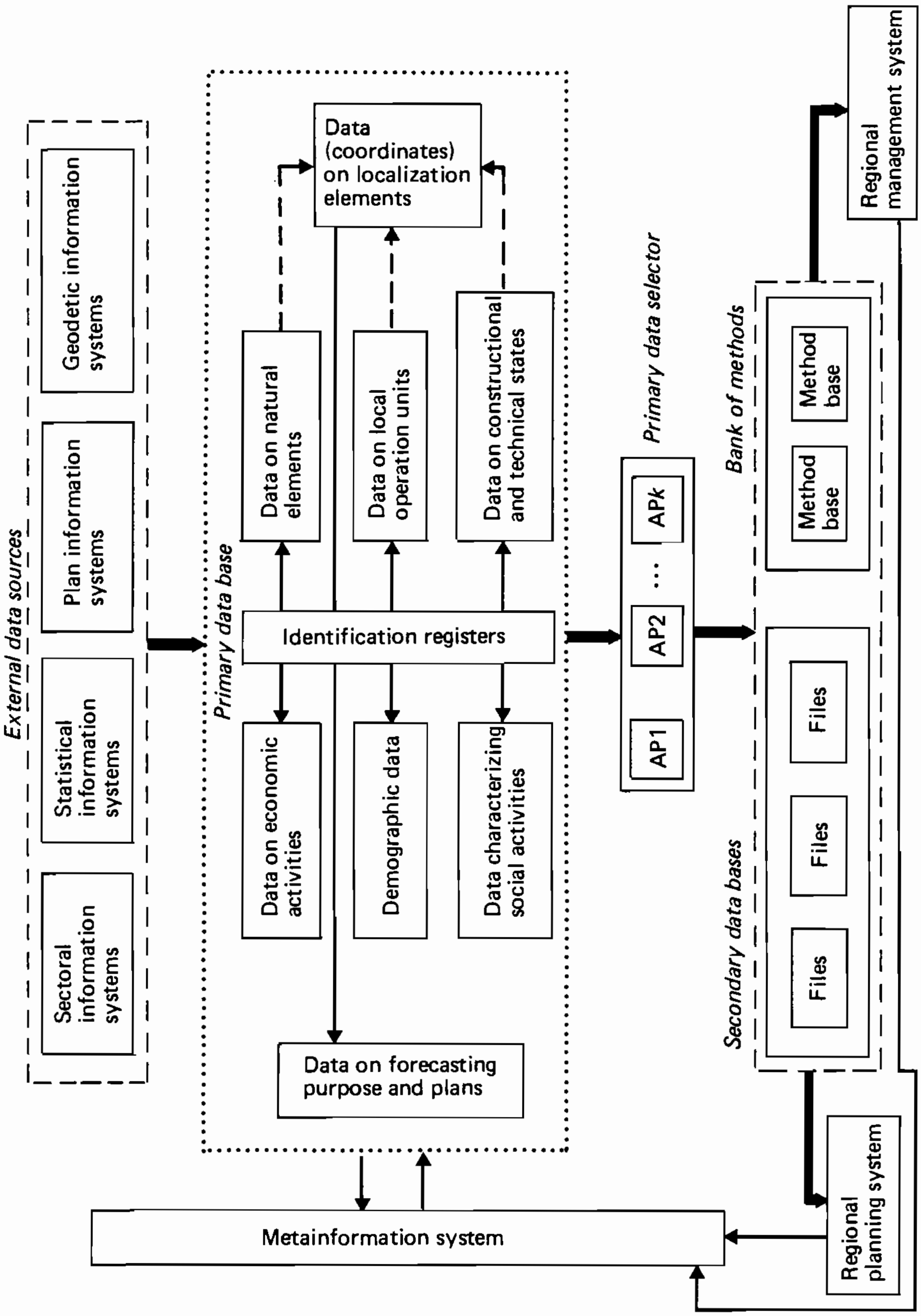

Figure 5 A possible design for an integrated regional information system. AP: application program.

information systems, and geodetic information systems. Because of its character and contents, this integrated system can be used as a source for other information systems.

3.2. *Primary Data Base*

The data on particular functional and natural components of a region, which are stored in external information systems, should be integrated so as to create a homogeneous primary data base. The primary data base is thus constructed as a multicriteria system. Its contents are divided into data on natural and technical conditions and data on economic and social phenomena. The data should characterize the present utilization of the territory, the planned changes in its utilization, the planned utilization and arrangement, forecast trends in development, and data on past utilization and conditions of the territory.

3.3. *Secondary Data Bases and Method Bases*

Secondary data bases are purpose-oriented subsets of the primary data base. Data from the primary data base are selected, reorganized, and aggregated by the primary data selector before entering the secondary data bases. The ultimate aim is to automate the functions of the secondary data bases, including updating, which is dependent on the changes in the primary data base.

As a rule, analytic methods and programs operate on data from the secondary data bases. The "bank of methods" consists of economic and mathematical methods, organized into so-called method bases, and a system of control programs. The objective of the bank of methods is to make it possible to construct regional models for analysis, planning, and design in an interactive mode, and to perform basic statistical operations, simulation applications, selection of options, etc.

3.4. *The Metainformation System*

The integrated regional information system should have broad links to external information systems, and its own primary data base. It is designed to provide the user with information through secondary data bases. The user's mode of operation should, preferably, be interactive, especially with regard to data evaluation. In view of these properties of the integrated system, it is suggested that a "metainformation system" would contribute to management of the data sources, unification of the data sources in the primary data base, and the increase of user knowledge about the contents and structure of the primary data base, as well as about methods of data analysis. More details of the metainformation system are given by Drozd (1981) and Dujnic (1982).

4. Conclusion

The improvement of regional information systems in centrally planned economies will contribute to progress in regional management systems. Regional information systems should also be built as integral parts of a state-wide information system. The main features upon which work should be concentrated are the system of regional indicators, the means for interpreting information, and, last but not least, the computing techniques used for processing data. The main effort at present is to ensure the integration of all aspects of regional information systems so as to achieve a higher efficiency of management.

References

Bandman, M. (1981) *Goal-Oriented Territorial Productive Complexes* (Novosibirsk: Siberian Branch of Academy of Sciences of the USSR) (in Russian).

Baranov, E.F., and I.S. Matlin (1981) *Methodological Principles of Developing a System of Models for Coordination of Sectoral and Regional Decisions* (Moscow: Central Economic–Mathematical Institute) (in Russian).

Drozd, A. (1981) *Methodological Approaches to the Design of an Information System for Regional Development Management in Czechoslovakia* (Dubna: Varsava) (in Russian).

Dujnic, P. (1982) New trends in the development of computerized statistical information systems. *Collaborative Paper* CP-82-46, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Fedorenko, M. (1982) Focus of economic science today. *Problems of Economy* (in Russian).

Granberg, A. (1982) Experience in the use of multiregional economic models in the Soviet Union. *Multiregional Economic Modeling: Practice and Prospect*, eds. B. Issaev *et al.* (Amsterdam: North-Holland), pp. 135–142.

Issaev, B., and A. Umnov (1982) Integrated economic balance of a regional system. *Working Paper* WP-82-118, International Institute for Applied Systems Analysis, Laxenburg, Austria.

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CHAPTER 8

Information Systems for Regional Development, with Special Emphasis on Developing Countries

T.R. Lakshmanan

1. Introduction

The interest in analysis and the supporting information systems for regional development is evident in many countries, irrespective of their sociopolitical system or level of economic development. It reflects a convergence of a variety of interests in regional development: the interest in the diverse regional consequences of national economic trends and public policies; the policy issues pertaining to a reduction of regional development differentials and maintaining the quality of the environment in the densely settled regions; and the need for a conscious national policy of regional development (Perloff and Leven 1964, Leven *et al.* 1970, Misra 1971).

The ability to respond to these regional issues both in scholarly activities and in the policy-making communities depends upon the acquisition and use of an information system appropriate to support regional decision-making processes. A regional information system designed to improve decision making should identify the information capable of improving different types of decisions, specify the relevance of and the acquisition plan for this information, and provide an organizing framework to facilitate access to and use of information in analysis and policy making (Hermansen 1971, Nijkamp 1982). Further, such information should tie into a regional or multiregional model since decisions affect the future.

Such a high degree of integration of regional development decision making and statistical development should be helpful in many ways. It should permit a coherent picture of the current state of the regional economies in terms of production, distribution, accumulation, and interregional trade, providing thereby an information base for decision making by both public and private organizations. It should help in the evaluation of regional impacts of national activities and policies regarding expenditures, taxes, energy, the environment, and the like. It should also contribute to a deeper understanding of regional development processes and toward a fuller theory of regional change and development.

The creation of an information system viewed in this fashion as a statistically implementable, analytic system can proceed from two perspectives: the general and the particular. From the general point of view, it is well to recognize that analytic interests and policy problems vary from country to country and what is needed is a systematic and coherent framework that can accommodate main bodies of data, such as regional stocks (human and physical assets) and flows (stock flows and flow stocks) and interregional product and monetary flows. Within this system, the individual user is left free to emphasize portions of the system and abbreviate, as seen fit, other parts of the system. For a particular point of view, the relevant data base for the kinds of analysis and policy issues in a specific country can be identified.

While such a dual view of the development of a comprehensive empirical framework and data system is evident in the evolution of national accounts, experience at the regional level has been relatively opportunistic and *ad hoc*, reflecting the long neglect of the regional dimension in development analysis. However, some recent regional data systems have sought to build on the pioneering systematic concepts of the US Committee on Regional Accounts and others (Hirsch 1964, 1966, Leven *et al.* 1970, Hagerstrand and Kuklinski 1971). Such information systems are emerging in the affluent industrial countries in response to needs of regional and metropolitan development (Kuklinski 1974, Benjamin 1976, Elfick 1979, Garnick 1980, Issaev 1982).

In developing countries, there has been a widespread commitment in the period since the Second World War to development planning and other forms of government intervention in the economies. This has brought in turn a greatly expanded need for data bases with which to inform the policies involved in these interventions. While the outpouring of economic data in response to this need has been impressive at the national level, there has been recent disquiet about the relevance and usefulness of the data (Stone 1976, Pyatt and Roe 1976, Pyatt and Thorbecke 1976). In the last decade, there has been a broadening of objectives of developing planning beyond growth of gross domestic product to include reduction of poverty and of income inequalities in society. This concern with income is just one example of a variety of distributional concerns (including that among regions). If the policy concern is with the reduction of inequalities of income, the analytic focus is legitimately on the characteristics of individuals (e.g. education, health, and location) that determine their economic adjustment potential. The data system appropriate to support such an inquiry should show numerically what is happening in the economy and how the living standards of different groups are related both to one another and to other aspects of national and regional economic activity.

The currently available national data bases in the developing countries do not provide this capacity.

The objective of this chapter is to identify the nature of the information systems necessary to support the analysis of development in the low-income countries, with their distributional problems – in particular, the regional dimension in national development. Since information systems do not exist independently of the conceptual framework underlying the issues surrounding the regional dimensions of development policy, Section 2 will explore these issues. What are the relative fortunes of regions as the national economy undergoes structural change and shifts in industrial capacity, in incomes, in consumption, and in trade patterns emerge? How effective are various mixes of investments, taxes, and subsidies in reducing regional inequalities? How should one direct the disposition of public and publicly controlled capital stock so as to provide more efficient (equitable?) regional growth patterns? How does one promote the equality of the metropolitan and densely settled environments? By formulating these issues, this chapter will attempt to describe the environment of regional decision making and provide an idea of how various elements of an information system should function from a rational or ideal viewpoint.

Since resources for information systems (as for other purposes) are scarce in low-income societies, the approach to improving data bases must necessarily be modular, and staged in steps. In this spirit we note, in Section 3, the current development of comprehensive national-level data systems – social accounting matrices – in many developing countries and identify the potential here for some useful regional ideas. In Section 4 we proceed to an identification of the first phase of an information system that would help in the choice of the level and type of regional public investments to promote desired regional growth patterns. Section 5 identifies the elements of a more comprehensive national system of regional information systems that go beyond the analysis of impacts of public sector developmental investments to consider effects of regional private and public expenditures on regional and national output, investment, income, and consumption. Further, these systems are concerned with the quality and spatial form of large, densely settled regions. We outline here the multiregional model implied in such a view of regional development policy. Finally, we offer some concluding comments.

2. Framework for Regional Development Information Systems in Developing Countries

We attempt here: (a) to sketch a modular analytic framework for regional development in developing countries, specifying a set of interconnected subsystems and the major relationships among the variables within and between these subsystems; and (b) to outline the components of a complementary information system.

We begin with a brief description of the emerging paradigm of development planning and its implications for regional development issues. We proceed to a delineation of the major elements of a multiregional economy, setting the stage for identifying the major regional development issues and the classes of requisite information. Finally, against these requirements, we suggest a phased strategy of information system development.

2.1. *The Emerging Paradigm in Developing Countries*

In the developing world, there has been over the last three decades an almost universal acceptance of the need for development planning. The record of development during this period, as judged by the standard indicator of growth of GDP per capita, is impressive by historical standards (growth rates of the order of 5% per year are frequent). Yet there has been a growing disenchantment in the last decade with the effects of growth maximization, the dominant approach since the Second World War. Acute poverty lingers on, unemployment grows, and the rise in living standards of the masses, to which economic growth is supposed to lead, is not much in evidence. The realization that large segments of the national populations have been virtually excluded from the benefits of growth and, further, that technological choices made in the promotion of growth are creating a structure of production that militates against income increases for the poor in the future has sparked the search for new development approaches.

The new approaches share certain features: an equity orientation emphasizing a direct attack on poverty and minimum-consumption thresholds ("basic needs"); and a recognition that more production and better distribution must be generated together to define development. Thus, in these approaches, distributional questions become part of the conceptual framework that previously focused only on growth.

This emerging focus on the distribution of income as well as growth is really part of a large variety of distributional concerns, including that between regions. While it is easy to see the role of individual characteristics, such as education and health, in the earning power and distribution of income, the significance of location or region has become evident only recently. If economic opportunities change and migration is indicated, there is no reason to assume that the cost of migration is necessarily lower than the social opportunity cost of moving capital. In this sense, region is an "immobilizing factor" and may be an operational and statistical proxy for other immobilities (e.g. ethnicity and race) as well (Leven *et al.* 1970). While some of the early work in this area followed the lead of Williamson (1965), who postulated an inverted-U relationship between the stage of development and the level of disparities, the notion that the regional disparities are a maximum at an intermediate stage of development – paralleling the earlier Kuznetz hypothesis pertaining to national development – is no longer believed to be an inevitable feature of the development processes. Land reform, supplemented by appropriate productivity-augmenting public policies, has led in some countries, such as South Korea and Taiwan, to rapid economic growth combined with a low level of inequalities in intermediate stages of development (Adelman 1974, Lakshmanan 1977). As a consequence, regional issues have become important in development planning (Misra 1971).

If the policy focus is on distributional issues integrated with growth, the analytic concerns shift to the various mechanisms of growth and to how value added in production is translated into incomes of various groups. In this case, the link is provided by factors of production. More generally, the framework that integrates regional growth and distribution should encompass the major elements of a functioning multiregional economy linked to the nation – a description of which we turn to next.

2.2. *The Elements of a Multiregional Economy*

The major elements of a multiregional economy are displayed in Figure 1 (Lakshmanan 1982). While the figure applies to each region of a country, the extensive links among the elements and between these elements in different regions occur through regional and interregional networks of transportation and communication and of monetary flows (Figure 1(a)). Interregional and regional–national flows of information are noted in Figure 1(b).

Three institutions and two media of exchange, or markets, comprise the elements or sectors of the regional economy. The institutions are households, businesses or industries, and government. The markets are the factor markets and product markets that link the institutions and serve as media of exchange. The exchanges involve not only goods, services, and individuals but also money and credit; and these flows take place across *space*. The regional and interregional transportation and monetary networks determine these exchanges (Figure 1(a)).

The household sector comprises individuals grouped as families, and unrelated individuals. Traditional governmental activities at the national, regional, and local levels are categorized into two groups: those that produce goods and services (e.g. post office, sewer service, and water supply) and those involving policy making (regulations, incentives, defense, etc.). The government sector in Figure 1 retains only the second group of activities or the policy-making function. The public enterprises that provide goods and services are included in the businesses or industries sector.

The industries sector includes the private and public enterprises in each of the regions that extract primary resources and acquire factor inputs, corresponding to their technology, to produce various goods and services. The circular flow depicted inside this sector is intended to indicate the broad range of interactions between industries. The value added is distributed partly to households as wages and interest (retained earnings are also a source of factor inputs). Taxes are paid out to government and transfers of various kinds are received from the government.

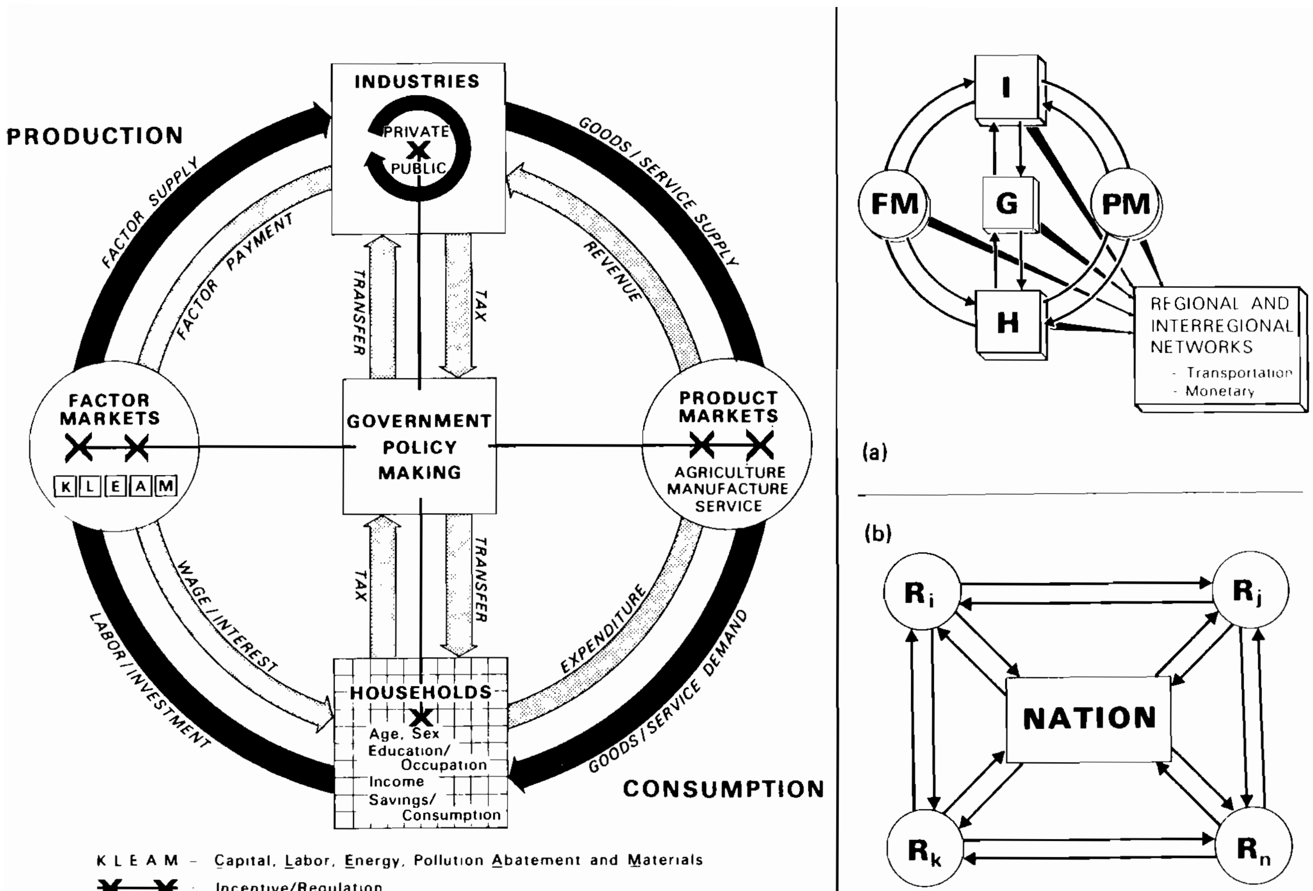

Figure 1 The elements of a multiregional economy. (a) Interregional links; (b) interregional and regional–national relationships.

Productive enterprises invest or disinvest in order to increase or decrease production, alter technology, or move to a different region as guided by changing markets, altered relative factor prices, and shifting interregional comparative advantage. Consequently an explicit analysis of comparative costs, dynamic factor substitution, and characteristics of labor supply, transportation, and other public investments at a regional level is necessary in order to track sectoral and spatial changes in production in the economy and the responses to economic proposals to improve specific regions.

The size and demographic composition – by ethnicity, age, and sex – of households in a region depend upon natural increase, family formation, and interregional migration processes. Diverse households in a region offer labor and capital to enterprises in return for wages, salaries, and interest. They consume a variety of goods and services for money and credit, pay taxes, and are eligible to receive transfers. Their participation in factor and product markets depends upon their assets (physical and human capital), income, savings and consumption behavior, and some institutional factors (e.g. discrimination in labor markets and housing). It is only by an explicit regional analysis of these determinants of market participation that it is possible (a) to determine the regional distribution of income and consumption among categories of households, and (b) to assess the effectiveness of social programs such as those that try to induce among some groups increased labor supply, higher income and household savings, and desired levels of consumption, etc.

Factor inputs are exchanged in factor markets for factor payments. Disaggregation of factor inputs into types of capital (K), labor (L), energy (E), pollution abatement (A), and materials (M) is represented by the KLEAM model in Figure 1. The product market links producers and demanders in the region and in the nation.

In its policy-making role, the government determines the system of incentives to promote both production and consumption. This incentive/regulation system, comprising subsidies, taxes, public capital investment, regulations, etc., affects households (tax deductions, training programs, health improvement, eligibility for transfer programs, traffic regulations, etc.), industries (investment tax credit, physical infrastructure, pollution regulations, etc.), and both markets (labor market regulations, resource rents, financial market regulations, etc.).

In addition to the coverage of all the major institutions and markets in the economy, we emphasize the explicit linkages between the sectors and markets. First, there is the need for full specification of a *multimodal* transportation system in such a manner that not only the transportation consequences of production and consumption (choice of mode and route, link costs, travel time, delays, congestion, and commodity flows) but also the consequences of transportation networks on the scale and location of production and consumption can be assessed.

Table 1 shows the mapping, noted earlier, from the structure of production in a region into the distribution of income. The relationship between the structure of production and the factor market is displayed in the top right-hand corner. In the top left, total income is allocated to institutions and particular households that provide factor services. This part of the table reflects the effects of the distribution of income before transfers based on asset distribution – viewed as including human skills as well as capital. The bottom left-hand corner shows effects of transfer payments, in terms of distribution of profits, taxation, and public social security payments. In this section aggregate income is broken down into disposable income of all institutions, including households. It is this causal interdependence that accounts for the substantial element of simultaneity that exists in the determination of output and incomes.

2.3. *Major Regional Development Issues and Requisite Information*

The job of the information analyst is to relate the regional development issues outlined above to the world of information. In other words, the analyst should translate the policy issues of adjusting for inequitable or inefficient allocations in the multiregional economies of the developing countries into desired pieces of information. Such a specification of information requires the formulation of models for regional social processes. The building of such models is a major prerequisite for an efficient design of information systems. Consequently, in what follows, we view an information system mainly as an automated system designed to make a specified model of regional development operational, as contrasted with the functions of acquisition, standardization, and convenient supply of information. While the latter functions are, no doubt, important (Nijkamp 1982), the focus of this chapter is on *what kinds of information* need to be collected rather than how to collect them.

Several options are open for a policy maker to adjust for inefficient or inequitable regional economic distributions. The traditional approach has been to attempt one or a combination of the following: subsidy payments, tax relief, transfer payments, etc.

A more direct option in dealing with regional inequalities in developing countries is to provide goods and services, primarily public capital, with the aim of supplementing and promoting the growth of private economic activities. The environment in which private sector activities operate is a function of human decisions – partly prior market decisions, but largely public sector decisions. The public sector not only provides public capital (e.g. irrigation, dams, power stations, and education) but also influences and controls to varying degrees the provision of transportation, communication, energy, health services, etc. by the private sector. The policy question is how to select the quantity, quality, and location of public and publicly controlled changes in regional capital stock so as to maximize desirable regional development. We need to know how the attractiveness of a region to industrial development changes as a result of improvements in accessibility, water quality, and water quantity. How does the productivity of the regional labor force increase with investments

Table 1 A framework for analyzing income distribution (adapted from Pyatt and Thorbecke 1976).

			Institutions (current accounts)			Totals	Production activities	Rest of the World
			Households	Enterprises	Government			
Income distribution before transfers	Factors of production	Labor	Labor income received by households			Factoral distribution of income	Wages	Net factor received from Rest of the world
		Other	Surplus for unincorporated enterprises to households	Operating surplus received by enterprises			Other factor income	
Distribution of factoral income minus total transfers	Institutions (current accounts)	Households		Profits to domestic households	Transfers to households	Distribution of disposable income		
		Enterprises			Transfers to enterprises			
		Government	Direct income taxes	Direct taxes on enterprises				
Rest of the World			Net nonfactor income paid to Rest of the World					

in health and education? In other words, an important part of our regional analytic system should establish the connection between public sector investments and the production and consumption behavior of regional enterprises and households.

The type of information required for this analytic system includes for each region, over time, the quality and quantity of available human and physical resource stocks, the quality and quantity of human and physical capital and materials currently input into production, the outputs by sector, and the impact of public investment programs on output.

A second major area of regional analytic concern is the structural changes in the regional system. How do the relative fortunes of regions change over time? How do the regional differentials in public expenditure influence the costs and feasibility of carrying out different economic activities within a region? What are the long-term effects of public services on the amenity level or the quality of the labor force in the region? What are the consequences for the level and composition of production of goods and services in the region? The information necessary for this type of analysis would require a description of the multiregional economies and the physical and monetary flows among regions. In other words, a comprehensive multiregional economic model is to be specified prior to identifying the kinds of requisite information.

2.4. *A Phased Strategy for Information Systems Development*

The requirements for the types of information identified above for aiding regional development decisions are difficult to meet. Indeed, affluent industrialized countries do not possess such national sets of regional development information systems. While regional development analysis demands them, information systems of this type are not likely to be available in the near future in developing countries.

While regional development analysis is likely to rely in the near future on data that in one way or another are inadequate, compared with the requirements outlined in the previous section, the outlook for regional development decision making is not bleak. The data in developing countries are rarely so inadequate that they do not help decision making to some degree. If a modular approach to regional economic analysis is taken, imperfect data can be utilized. We propose an incremental, three-pronged approach to the development of information systems in developing countries.

First, it is well to recognize that reliable national statistics to support national development decisions are more likely to be available and accurate in many developing countries for some time to come (e.g. statistics on outputs, factor inputs, public capital, government expenditures, transportation and monetary phenomena, and interindustry accounts). As a first step, it may be necessary to translate these statistics into regional statistics.

In fact, many regional statistics in the United States and elsewhere were developed by such means. For example, very few regional input–output tables are developed by survey methods in the US. In most cases, national input–output matrices are converted by a variety of non-survey methods (e.g. use of location quotient) into regional input–output tables (Schaffer and Chu 1969, Morrison and Smith 1974, Lakshmanan *et al*. 1979). We propose the initial strategy of devising appropriate short-cut methods for producing regional data in this fashion. In many developing countries, there is currently a major effort to develop a social accounting matrix (SAM) at the national level. We shall explore in the next section the potential that the SAM framework holds for analyzing economic growth and income distribution issues together for regional development.

A second and parallel effort would be to focus on a major regional development issue and build the requisite data base for it. We propose in Section 4 a system for analyzing the effects of physical and human public investments, a crucial activity in most developing countries. Further, we suggest preliminary efforts to identify a multiregional model and the national system of regional accounts.

3. The Social Accounting Matrix as a Regional Information System

Recent concerns with income distribution and poverty in national development planning acted as an incentive to the creation of a comprehensive data base system, known as the social accounting matrix, for developing countries. Originally proposed by Richard Stone, SAM is an analytic system for interrelating the structure of production, the distribution of value added by producers, and consumption, savings, and investment. Viewed in this fashion as an integration of the Keynesian income and product accounts and the Leontief input–output system, SAM has been implemented in several countries, including Sri Lanka, Malaysia, and Egypt (Pyatt and Roe 1976, Pyatt and Thorbecke 1976).

SAM is one representation of the circular flow of relationships between the various elements of economy as displayed in Figure 1. As the households satisfy their needs, they generate demand for goods and services. This effective demand for goods leads to the production of commodities. In turn, the demand for factors of production yields factoral income distribution and GDP. Finally, the factoral income distribution is mapped into a distribution of income over households, enterprises, and government, as shown in Table 1.

While SAM provides a comprehensive conceptual framework for economic analysis, its development has been modular, as various subsystems were developed serially and linked. Table 2 presents the social accounting matrix developed for Sri Lanka. A noteworthy aspect of this SAM is the distinction made between households located in different labor markets: urban, rural, and estates (plantations). The recognition of different parts of the labor market is intended to show the dependence of

Table 2 A social accounting matrix for Sri Lanka, 1970 (in millions of rupees) (source: Pyatt and Thorbecke 1976, *Planning Techniques for a Better Future*, pp.86–87. © 1976, International Labour Organization, Geneva).

Receipts		Expenditures: 1 Factors of production — Labor: Urban	Labor: Rural	Labor: Estate	Other: Housing	Other: Other private	Other: Public	2 Institutions — Current accounts — Households: Urban	Households: Rural	Households: Estate	3 Private corporations
1 Factors of production — Labor	Urban										
	Rural										
	Estate										
1 Factors of production — Other	Housing										
	Other private										
	Public										
2 Institutions — Current accounts — Households	Urban	1673			137	662					434
	Rural		3185		330	3026					203
	Estate			711	31	30					7
3 Institutions — Current accounts	Private corporations				135	1266					
4	State corporations						174				
	Government							368	194	4	272
5	Combined capital account							519	807	11	527
6 Production activities	Tea							14	55	7	
	Rubber										
	Coconuts							54	208	27	
	Rice							158	760	102	
	Other agriculture							357	980	139	
	Food and drink							253	541	82	
	Other industry							258	621	69	
	Construction										
	Trade and transport							410	1074	122	
	Private services							405	920	85	
	Government services										
7	Rest of the world							207	741	143	
	Totals	1673	3185	711	633	4984	174	3003	6901	791	1443

Table 2 (continued)

Expenditures															
4		5	6											7	
			Production activities												
State corporations	Government	Combined capital assets	Tea	Rubber	Coconuts	Rice	Other agriculture	Food and drink	Other industry	Trade and construction transport	Trade and private transport services	Private services	Government services	Rest of the world	Totals
			5	5	9	25	75	46	182	81	414	276	555		1673
			43	158	67	706	247	68	259	159	487	276	715		3185
			526	133	11		5	4	2	5	8	12	5		711
												633			633
			13	24	442	282	1259	184	604	742	1424	123		–113	4984
							11	12	109	–8	–1	73			174
	91													6	3003
	151													6	6901
	6													6	791
	57													–15	1443
	237														411
104		313	33	4	14	10	19	288	216	66	130	76	29	94	2234
307	43													425	2639
		–55										2	2	839	864
		25							8					341	374
		29						239	8			6	4	2	577
		105				1082			2			15	18		2242
			11	1		2	95	63	34	3		39	16	106	1846
		37				9	11	24	188			29	8	94	1276
		72	97	24	9	35	69	49	554	417	172	37	66	241	2790
		1595							1		7	50	92		1745
		154	50	10	8	44	23	95	249	206	96	42	59	203	2845
			11	3	7	15	1		4	9	38	55	37	287	1877
	1649														1649
		364	75	12	10	32	53	204	370	65	70	133	43		2522
411	2234	2639	864	374	577	2242	1846	1276	2790	1745	2845	1877	1649	2522	

each on different productive activities; for example, estate labor force primarily depends upon the tea and rubber industries. Thus, this matrix is still a national-level data base without relevant regional detail.

It is very likely that many more countries will develop SAMs in the near future to support national-level development planning. With resources limited, an interim approach would be to allocate major aggregates from the national level to the regional level. One such approach to regionalize part of SAM – the interindustry and final flow matrix – has been proposed by Hewings (1983), taking advantage of earlier work by Wilson and others (Wilson 1971, Boyce and Hewings 1980). This approach draws upon the literature on entropy maximization methods that help to allocate a vector of row and column totals of interregional flows into the most probable distribution of individual flows between regions. It is an optimization formulation in which, in addition to the usual accounting balances and the nonnegativity constraints, there is an overall cost constraint on flows between sectors and regions.

While this procedure provides a quick method for obtaining interregional intermediate and final flows from the input–output portion of the national SAM, the behavioral aspects of the cost formulation are unclear. They could be improved by substituting the formulation of Batten (1981). Batten would substitute an overall transport capacity constraint for outgoing goods, related to the capacity of each region to ship goods out by each mode of transport, instead of the cost constraint notion used by Hewings. In any case, the Hewings approach is one example of many nonsurvey methods of regionalizing national data (Lakshmanan *et al.* 1979). By utilizing such techniques, regional development planners can take advantage of ongoing national statistical systems such as SAM to develop information on the regional structure of production. Such information is useful for a variety of analyses of regional impacts. For a more policy-oriented analysis of regional development, one has to turn to other models.

4. Public Capital and Regional Development

As noted earlier, the literature on sources of economic growth has identified the importance of investment in social overhead (education, health care, etc.) and physical overhead (roads, power, ports, etc.) (Denison 1967, Klaassen 1968, Correa 1970). There is a twofold return on the provision of these social and physical amenities. First, better education, health care, and transport facilities improve the welfare of the individuals demanding these amenities, in the form of better skills, less absenteeism, lower transportation costs, and so on. In the long run, this improves their productivity, output, and income. This income effect, resulting from the effective demand for amenities, is the amenity demand effect. The second income effect derives from the attractiveness that the amenities of a region pose for industries outside the area, especially more productive industries that demand superior facilities. This second income effect is the amenity supply effect.

Affluent societies, in which more resources can be mobilized, enjoy higher levels of these amenities. In developing societies, the levels of these amenities resulting from investments in transportation, power, health care, education, and nutrition will be lower, and perhaps in some cases below threshold levels, where their effects on output are negligible. In countries and regions whose populations must endure widespread epidemics, nutritional inadequacies, and poor accessibility, it is likely that productivity is below its potential level with existing stocks of capital and effective labor.

Consequently a major thrust of development policy in less developed regions is to provide more of these capital goods in transportation, power, education, health care, etc. so as to increase the production potentials and incomes of the regions. Since these investments are either provided in the public sector or are under public sector control, the crucial analytic questions are: How much and what types of public investment should be placed at which locations, and when, in order to promote regional development?

Since infrastructure investments are large and "lumpy" in developing countries with scarce resources, it is important to understand the nature of the contributions such investments make to regional income. It is the nature of public capital that it is available to all firms in a region. In this respect, public capital may be thought of as entering the production functions of all regional firms. However, it is conceivable that only some kinds of public capital affect the output in some industries. Some investments may augment labor, improving its skills and productivity; others may improve the productivity of physical capital. Further, some types of public investment may play a greater role in output determination in the earlier stages of regional growth, while other types may come into play later. Some investments may even have an adverse effect. It is important to analyze *ex ante* such effects of regional public investments in order that scarce resources are optimally deployed to improve the performance of private capital in a region and to encourage growth in less developed regions.

Such knowledge can be gained from a formulation of a regional production function:

$$X_{ij}(t) = \alpha_{ij}(K_{ij}(t), L_{ij}(t), SK_{mj}(t)), \tag{1}$$

where

$X_{ij}(t)$ is the output in industrial sector i, region j at time t,

$K_{ij}(t)$ is the stock of private physical capital of type i in region j at time t,

$L_{ij}(t)$ is the labor input in sector i, region j at time t, and
$SK_{mj}(t)$ is the stock of social overhead of type m in region j at t.

Such a production function has been estimated for Puerto Rico and Japan, using the Cobb–Douglas and CES functional forms (Lakshmanan and Fu Chen Lo 1970, Mera 1973).* From such an analysis carried out during different stages of development one can estimate the output elasticities of different types of public investments and the various effects of different investments at different stages of development.

Since we believe that it is crucial to know about the effects of changes in capital stocks and human resources on productivity in order to stimulate regional development, such analysis should receive priority in developing countries. The requisite information, identified below, should form the core of any information system to be created to assist regional development in such countries.

The requisite information should be comprehensive and include an inventory of the regional resources – physical and human. The concept of capital should include not only privately owned capital but also that owned by the public sector and nonprofit institutions. Further, labor and capital should be disaggregated into several classes of labor and capital inputs. In the case of private business capital, details for each sector of industry are necessary. Within each sector, knowing the total value of machinery and buildings would be sufficient.**

Public sector capital, distinguished by type, can be measured in value or preferably in capacity terms. The rationale for measuring public capital capacity, without adjustment for quality, is that it is the nature of public goods that the stock of capital determines the size of the group that can be serviced, and the values of the variable inputs (e.g. quality of teaching materials) determine the quality of the service (Leven *et al.* 1970). Further data on output from each sector of industry by region are needed.

So far the focus has been on the types of variables that should be included in regional information systems. Another issue is the geographic or areal dimension of data. While this will vary with the purpose, in this chapter we prefer a labor market area that, as in the US case, corresponds to the functional economic area.

What is proposed here is a data system on regional resources and output to address the question of public investment, invariably the primary issue in the development of undeveloped or backward regions. Consequently it is viewed as the core of the information system, to which other

* Current research in this area utilizes flexible functional forms (quadratic) and separates private inputs as variable and public capital as quasifixed inputs, providing thus a structural specification (Elhance 1982).

** Conceptually, the value would be the acquisition cost adjusted for price changes, depreciation, and subsequent investment.

subsystems can be added in a modular fashion. We turn next to a consideration of such a broader system for multiregional development planning.

5. Multiregional Information Systems for Development

In the course of development, the mix and levels of regional activities evolve in response to structural changes in the national economy and to a variety of growth stimuli and public policies. The national structural changes result from increasing diversity of industrial capacity and development, rising incomes, shifting consumption patterns, and the increasing incorporation of the national economy into the international production and trading system. The growth stimuli and public policies include the mix of subsidies, taxes, public investments, and the like used to encourage growth as well as overall policies on energy, environment, trade, etc.

Various regions in a country respond to those stimuli differently, according to their stock and quality of physical and human capital, industrial mix, and natural resources. Policy makers in developing countries would wish to know about the relative fortunes of regions as the national economy evolves in this manner in the next decade or two. They also wish to understand how the regions would fare if new international trade barriers were introduced or energy prices increased sharply. Further, they want to know about the shifts in comparative advantage of regions if new national or regional policies are introduced, if old policies are modified or abandoned, or if a cluster of related development policies are introduced.

A model of the multiregional economy is a prerequisite for addressing effectively such analytic issues. In North America, the Soviet Union, and Europe a number of such multiregional models of varying degrees of complexity have been developed (Bolton 1982, Issaev *et al.* 1982). These range in scope from models that deal with one aspect (e.g. labor market or transportation) all the way to comprehensive models that deal with production, transportation, labor markets, income generation, and the regional government. The comprehensive multiregional models are increasingly eclectic in structure, combining elements of input–output methods, Keynesian macromodeling, neoclassical factor substitution, location analysis, econometric modeling, and mathematical programming. Such models, linked to a national model, can be used for regional forecasting and policy evaluation (Lakshmanan 1981, Bolton 1982, Issaev 1982).

In the developing countries, regional modeling is still an infant activity. A variety of single-region input–output models have been estimated for some states in India. An interregional transport system model has been developed for 31 regions in Korea (Kim 1982). This model is a linear programming model of Korea, incorporating five-sector input–output technology, and estimates an optimum multimodal transport sector program. Another example is provided by the interregional input–output simulation model for Kenya (Bigsten 1980). This nine-sector interregional (eight regions) input–output model, in which interregional trade coefficients are estimated by entropy-maximizing methods, has been used for analyzing the effects of regional policies relating to private and public capital on interregional income inequities.

Our objective here is to concentrate on some elements of the structure of broader multiregional models necessary to support regional development policies in developing countries. Figure 2 displays the essential components of such a model, comprising five elements of a multiregional model linked to a national model. Each of the rectangular elements represents a block of equations.

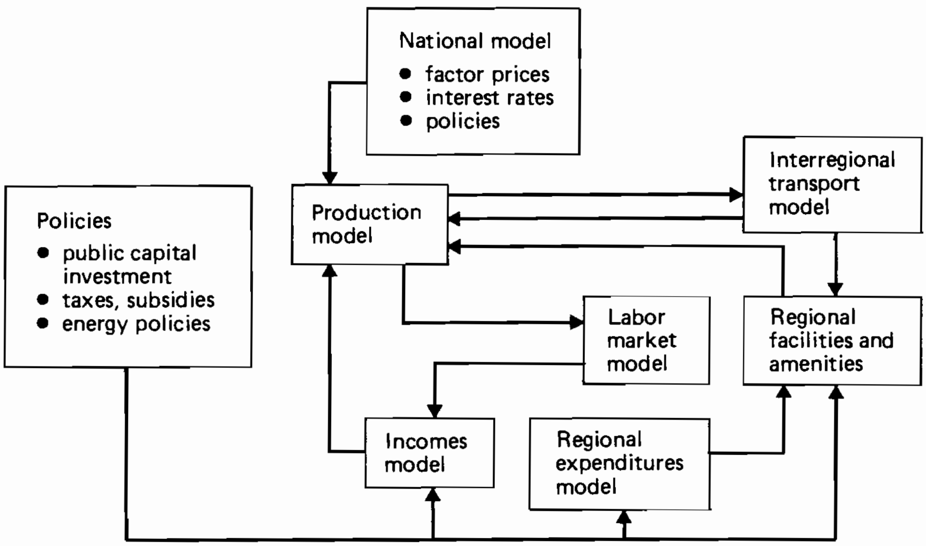

Figure 2 The major elements of a multiregional model for development.

The annual model maintained at the national level by the development agency could serve as the national model and serve to "drive" the regional models early in their application. (Later, the more realistic hybrid versions – a mixture of top-down and bottom-up – can be used.) The interrelated production and transport models should form the core of the regional model. A labor market block, an income determination block, and a block for regional government expenditures round out the model. The regional facilities and amenities block is determined by the level of regional government expenditures and in turn affects the comparative advantage of the region for production activities and hence the next cycle of regional production. Various specifications exist for such interlinked models (Lakshmanan 1981, 1982, Issaev 1982, Bolton 1982).

The data requirements for such a model depend partly on the type of specification used. If input–output technology is used in the regional context, the data requirements in terms of regional technology and interregional trade coefficients are more severe than in the use of other production functional forms. The labor market, incomes, and regional expenditures data bases are now beginning to be generated in some countries, such as India. Many countries have developed interregional data on goods flow by mode for one or two points in time. Thus, while all the data bases for the models in Figure 2 may not be available in any one country, such information systems can be developed in time.

As noted earlier, our specification of the information systems for multiregional development in developing countries is more from the general rather than the particular perspective. The classes of information have been the focus of interest. In the context of specific analytic priorities and statistical history, of a country and of regions, the information systems can be detailed and organized.

6. Concluding Comments

The development of information systems to support regional development is in the early stages in affluent and low-income economies alike – a reflection of the long neglect of the regional dimensions in development analysis. However, recently a number of regional information systems linked to a variety of multiregional models have been developed in the affluent industrialized countries.

In developing countries, with their strong commitment to distributional issues in development planning, regional issues have come to the fore. While the demand for the requisite regional information systems is growing rapidly, such information systems are unlikely to be available in the near future in many of these countries. In the short run, the quality and quantity of information likely to be available in some countries may support mainly informal use as descriptions of regional conditions. However, as the pace of development quickens and as newer styles of planning and decision systems evolve in these countries, a modular, staged approach to information system development is warranted. It is in this spirit that we suggest a three-pronged, complementary approach to the development of regional information systems in developing countries.

The first approach is "guided opportunism." If we assume that limited resources are more likely to be expended more heavily in these countries on national-level data bases, the first strategy is to utilize a variety of available methods to transform aggregate data (such as the social accounting matrix) from the national to the regional level. Such an approach of regionalizing national data bases has been used for two decades in the US and elsewhere.

The second approach is to develop a regional data base for the central issue of regional development planning in developing countries. This pertains to choices of the level, type, timing, and location of public investments to stimulate regional growth.

The third approach is the more ambitious national system of regional information systems to support multiregional development planning. Here, as elsewhere in the chapter, we view the regional information system as a statistically implementable analytic system, having identified the major analytic tasks and requisite types of data base.

References

Adelman, I. (1974) South Korea. *Redistribution with Growth*, eds. H. Chenery *et al.* (London: Oxford University Press).

Batten, D. (1981) Entropy, information theory, and spatial input–output analysis. *Ph.D. Dissertation*, Umeå University, Umeå, Sweden.

Benjamin, B. (1976) *Statistics and Research in Urban Administration and Development* (The Hague: International Association for Regional and Urban Statistics).

Bigsten, A. (1980) *Regional Inequality and Development: A Case Study of Kenya* (Farnborough: Gower).

Bolton, R. (1982) The development of multiregional economic modeling in North America: Multiregional models in transition for economies in transition. *Multiregional Economic Modeling: Practice and Prospect*, eds. B. Issaev *et al.* (Amsterdam: North-Holland), pp. 157–170.

Boyce, D., and G. Hewings (1980) Interregional commodity flow, input–output and transportation modeling: An entropy formulation. *Paper* presented at Conference on Multiregional Models, First World Regional Science Congress, Cambridge, MA.

Correa, H. (1970) Sources of growth in Latin America. *Southern Economic Journal* 37:17–31.

Denison, E.F. (1967) *Why Growth Rates Differ* (Washington, DC: Brookings Inst.).

Elfick, M. (ed.) (1979) *URPIS Seven* (Melbourne: Australian Urban and Regional Information Systems Association).

Elhance, A. (1982) Impact of social overhead capital on production activities. Regional dimensions. *Ph.D. Dissertation Proposal*, Department of Geography, Boston University, Boston, MA.

Garnick, D.H. (1980) The regional statistics system. *Modeling the Multiregional Economic System: Perspectives for the Eighties*, eds. F.G. Adams and N.J. Glickman (Lexington, MA: Heath), pp. 25–48.

Hagerstrand, T., and A.R. Kuklinski (eds.) (1971) *Information Systems for Regional Development* (Lund, Sweden: Gleerup).

Hermansen, T. (1971) Information systems for regional development: Issues and problems. *Information Systems for Regional Development*, eds. T. Hagerstrand and A.R. Kuklinski (Lund, Sweden: Gleerup), pp. 1–37.

Hewings, G.J.D. (1983) Regional and interregional accounting systems for development planning under conditions of limited information. *Urban and Regional Policy Analysis in Developing Countries*, eds. L. Chatterjee and P. Nijkamp (Aldershot: Gower) (forthcoming).

Hirsch, W.Z. (ed.) (1964) *Elements of Regional Accounts* (Baltimore, MD: Johns Hopkins University Press).

Hirsch, W.Z. (ed.) (1966) *Regional Accounts for Policy Decisions* (Baltimore, MD: Johns Hopkins University Press).

Issaev, B. (1982) Multiregional economic models in different planning and management systems. *Multiregional Economic Modeling: Practice and Prospect,* eds. B. Issaev *et al.* (Amsterdam: North-Holland), pp. 83–95.

Issaev, B., P. Nijkamp, P. Rietveld, and F. Snickars (eds.) (1982) *Multiregional Economic Modeling: Practice and Prospect* (Amsterdam: North-Holland).
Kim, T.J. (1982) Coal/cement distribution and optimum transportation sector investment strategy. *Technical Report*, Korea Institute of Science and Technology.
Klaassen, L.H. (1968) *Social Amenities in Area Economic Growth* (Paris: OECD).
Kuklinski, A.R. (1974) *Regional Information and Regional Planning* (The Hague: Mouton).
Lakshmanan, T.R. (1977) Income inequality and poverty in urban Latin America. Unpublished paper.
Lakshmanan, T.R. (1981) A multiregional model of the economy, environment and energy demand. *Paper* prepared for 51st Conference of Southern Economic Association, New Orleans, LA, November (to be published in *Economic Geography*).
Lakshmanan, T.R. (1982) Integrated multiregional economic modeling for the USA. *Multiregional Economic Modeling: Practice and Prospect*, eds. B. Issaev *et al.* (Amsterdam: North-Holland), pp. 171–188.
Lakshmanan, T.R., and Fu Chen Lo (1970) A regional growth model for Puerto Rico: Analysis of municipal growth patterns and public investment. *Report*, Pittsburgh CONSAD Research Corporation.
Lakshmanan, T.R., P. Kroll, L. Chatterjee, W. Barron, and M. Pappas (1979) *The SEAS Regional Model* (Washington, DC: US Environmental Protection Agency).
Leven, C.L., J.B. Legler, and P. Shapiro (1970) *An Analytical Framework for Regional Development Policy* (Cambridge, MA: MIT Press).
Mera, K. (1973) Regional production functions and social overhead capital: An analysis of the Japanese case. *Regional Science and Urban Economics* 3(2):157–186.
Misra, R.P. (1971) The diffusion of information in the context of development planning. *Information Systems for Regional Development*, eds. T. Hagerstrand and A.R. Kuklinski (Lund, Sweden: Gleerup), pp. 119–136.
Morrison, W.I., and R. Smith (1974) Nonsurvey input–output techniques at the small area level. *Journal of Regional Science* 14:1–14.
Nijkamp, P. (1982) Information systems for multiregional planning. *Collaborative Paper* CP-82-27, International Institute for Applied Systems Analysis, Laxenburg, Austria.
Perloff, H.S., and C. L. Leven (1964) Towards an integrated system of regional accounts: Stocks, flows, and the analysis of the public sector. *Elements of Regional Accounts*, ed. W.Z. Hirsch (Baltimore, MD: Johns Hopkins University Press), pp. 175–210.
Pyatt, G., and A. Roe (1976) *Social Accounting for Development Planning with Special Reference to Planning in Sri Lanka* (Cambridge, UK: Cambridge University Press).
Pyatt, G., and E. Thorbecke (1976) *Planning Techniques for a Better Future* (Geneva: International Labour Office).
Schaffer, W., and K. Chu (1969) Nonsurvey techniques for constructing regional interindustry models. *Papers of the Regional Science Association* 23:83–101.
Stone, R. (1976) Foreword. *Social Accounting for Development with Special Reference to Planning in Sri Lanka*, eds. G. Pyatt and A. Roe (Cambridge, UK: Cambridge University Press), pp. xvi–xxx.
Williamson, J.G. (1965) Regional inequality and the process of national development. *Economic Development and Cultural Change* vol. 13.
Wilson, A.G. (1971) *Entropy in Urban and Regional Modeling* (London: Pion).

PART C

Information Systems and Models in a Spatial Context

Information Systems for Integrated Regional Planning
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CHAPTER 9

Information Systems for Regional Labor Markets

Piet Rietveld

1. Introduction

The situation of the labor market, as reflected in the amount of unemployment, wage levels, and the quality of working conditions, is an important aspect of socioeconomic conditions. It is not surprising, therefore, that national authorities have developed information systems for labor markets as a basis for an adequate socioeconomic policy.

A major feature of the labor market is that it is segmented: it consists of a large number of submarkets that are more or less independent of each other. Submarkets may be distinguished by, for instance, type of occupation (e.g. blue collar or white collar) and by region. Neglect of this segmentation leads to an inappropriate understanding of labor market phenomena. Therefore, distinctions of the type mentioned above should be included in information systems for the regional labor market.

This chapter discusses how the regional dimension has to be included in information systems for the labor market. Obviously, a properly regionalized information system would be of value for regional and national authorities, in addition to being of use to other groups, such as firms, labor unions, and research institutions.

In the short run, the information that can be produced by information systems is determined by their structure and inputs, which means that the demand for information has to be adapted to the given supply. In the long run, the structure and inputs no longer need to be considered as given, however, and one may develop systems to meet particular requirements. Obviously, somehow the urgency of wishes for extra information has to be traded off against the additional costs of improving the systems.

In this chapter we will first formulate desiderata for information systems, and then discuss possible ways of meeting these desiderata. This will be done for the following subjects: the regionalization of labor markets (Section 2), the statistical data base (Section 3), and the use of impact and forecasting models in connection with regional information systems (Section 4).

2. Choice of Regionalization

2.1. *Regionalization: Desiderata*

One of the first questions to be answered when developing a regional information system is what kind of regionalization is required. This may have far-reaching consequences for the spatial level at which data have to be collected. We will find that the appropriate regionalization depends on the aims of the users (e.g. Johnston 1970).

Essentially, three types of regionalization principle can be distinguished (Nijkamp and Paelinck 1976):

- homogeneity with respect to one or more characteristics;
- functionality with respect to internal spatial relationships;
- administrative competence.

Homogeneity is useful, for example, when social welfare programs require regions to be identified that have a high level of unemployment. Functional regions, such as the standard metropolitan labor area (SMLA), are useful, for example, for studying the impacts of economic policy on regional labor markets. Administrative regions are the natural spatial unit for the corresponding regional authorities.

Considerable flexibility is required from information systems so that they can produce information according to different methods of regionalization. Ideally they should be able not only to produce information according to a specified regionalization, but also to respond to new forms of regionalization. Flexibility is also required with respect to the time dimension, because the three regionalization principles may in time give rise to changes in the partition of space. For example, although the borders of certain administrative regions may be fixed for long periods, the borders of other administrative regions may change considerably. If these changes are not taken into account they may give rise to misleading results. Norton (1979) has shown that the development pattern of urban population figures in the United States depends considerably on the extent to which annexations by urban centers of surrounding municipalities are taken into account. Another example can be found in the field of intermunicipal migration. In the Netherlands until recently no data were available on intramunicipal movements. Thus, intermunicipal movements had to serve as an indicator of overall residential mobility. In the course of time the number of municipalities decreased considerably through fusions. This had a negative influence on the volume of intermunicipal movements, which reduced the usefulness of the latter as an indicator of overall residential mobility. Peters (1982) has made a systematic treatment of fusions and border corrections between the basic areal units of an information system.

Another important issue concerns the development of functional urban areas (such as SMLAs). Clearly, in times of substantial socioeconomic change functional relationships in space will change as well, giving rise to continuously changing functional urban areas. Many discussions of the question whether urban development is now in a phase of deurbanization are obscured because it is not made clear whether functional urban areas are assumed to be fixed at certain historical borders or whether they are allowed to change in the course of time.

Having discussed the principles according to which regionalization can be carried out, we will pay attention to the way in which regionalization can be achieved in practice. This can be done by clustering basic areal units (Fischer 1982). Although clustering gives rise to a certain loss of detail, it leads to an improved understanding if carried out appropriately, as indicated by Figure 1.

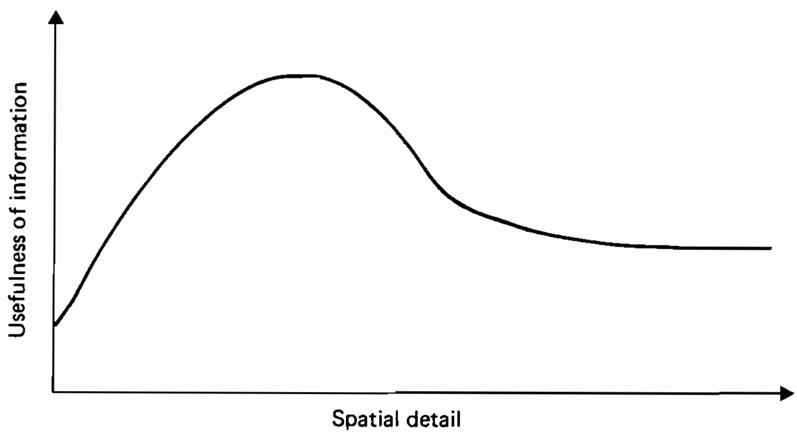

Figure 1 Relationship between spatial detail and usefulness of information.

Clustering methods are comparable with other multivariate methods, such as factor analysis, in the sense that they can be used to represent the main features of a complex phenomenon by means of as little information as possible. Clustering may be especially useful when the spatial scale of the basic areal units differs considerably. There are many points to consider in a clustering procedure:

(1) the fixation of a maximum and minimum spatial scale for clusters;
(2) the requirement that every areal unit in a cluster has at least one common border with another unit in that cluster (contiguity condition);

(3) the requirement that each unit is a member of a cluster (exhaustiveness condition);
(4) the requirement that each unit is a member of not more than one cluster (clusters should not be overlapping);
(5) the choice of regionalization principle (functionality versus homogeneity) and the choice of the variable(s) by means of which the functionality or homogeneity is to be measured;
(6) the choice of a hierarchical or nonhierarchical clustering procedure;
(7) the choice of clustering objective (e.g. maximization of the mean internal cluster homogeneity).

It is clear from this list that once the regionalization principle has been formulated, there are still many choices to be made before clustering can be carried out.

In recent years, in the sphere of spatial modeling, attention has been brought to the fact that the type of regionalization used can affect the modeling results (e.g. Openshaw 1978, Baumann *et al.* 1982). It appears that the correlations between variables measured at a certain spatial level depend significantly on the spatial scale and on the regionalization. Therefore, all of the above-mentioned authors conclude that the regionalization has to be determined simultaneously with the estimation of relationships between the variables in which one is interested. The common practice is that first a regionalization is determined and then one estimates the relationship between variables. The consequence of the former approach is that each problem requires its own regionalization.

2.2. *Regionalization: Practice*

Regionalization is a common geographic classification and clustering problem marked by two major choices: those of spatial scale and level of aggregation. This also applies to labor market demarcations.

To what extent is it possible to provide the information required for a particular regionalization? Several factors restrict the usefulness of regional information systems in this respect. One factor is insufficiently developed software, although this problem can be removed relatively easily by improving the software. Also, computer programs to produce clusterings of areal units according to specific rules are well developed now so that they can, in principle, be included in regional information systems. However, these programs are in general only useful if an explicit contiguity constraint is included.

Another problem, which is much more difficult to solve, concerns the size of the basic areal unit for which data are collected. This size should be sufficiently small to make clusterings valid for various purposes. If data are collected by sampling, the costs will increase considerably with the number of areal units distinguished. Therefore, one may expect that sampling with a high spatial detail will be relatively infrequent. In addition, when there is a large number of small areal units one may easily run into trouble with statistical confidentiality (Dalenius 1977). In such a case information may either be suppressed or be made public with a low level of detail. Hence there must be a compromise between the spatial detail required and the detail considered appropriate from other points of view (e.g. sectoral detail). A final problem concerns interareal linkages such as commuting, migration, and trade. Since the number of spatial interactions depends quadratically on the number of spatial units, small spatial units may give rise to huge stocks of data (Coombes *et al.* 1980). We conclude that a data base with the advantage of great regional detail can only be achieved at high cost.

In practice one often finds that some data are available at a high spatial level (e.g. provinces) and other data at a low spatial level (e.g. municipalities). It is certainly not necessary to aggregate the municipal data to the provincial scale before something meaningful can be done with them. A *multilevel* approach, in which different phenomena are dealt with at different spatial levels, may prove to be fruitful. For example, similar to the central place theory, according to which services are provided at different spatial levels (developed by Christaller (1935)), it can be argued that the spatial extension of labor markets in some sectors may be greater than in other sectors.

The advantage of a multilevel approach becomes clear when data bases for different policy fields, such as labor market policy, economic policy, and physical planning, are to be used jointly. It can then be argued that functional urban areas form the appropriate spatial units from the viewpoint of regional economic and labor market policy, whereas much smaller spatial units are necessary for physical planning (Van Engelsdorp Gastelaars 1981).

Our emphasis on flexibility with respect to the appropriate regionalization does not alter the fact that there is certainly a need for a *general-purpose regionalization* that meets the information needs of the majority of the users (although, from a methodological viewpoint, it would be hard to construct). Such a regionalization may provide an important means of achieving standardization within the data base of one particular information system, and of improving the integration of different information systems. Functional economic regions are a good candidate for general-purpose regionalization. It is reasonable to require that a general-purpose regionalization satisfies the conditions of contiguity, exhaustiveness, and no overlap (Section 2.1). A good way to give content to functionality is to construct regions so that internal commuting flows are high and interregional commuting is insignificant. As a result one arrives at roughly overlapping residential and working regions. In Section 2.1 we noted that spatial relationships may change over time so that the borders of the functional economic regions would have to be revised. To avoid this problem as much as possible, it is advisable to construct regions that do not have to be revised frequently. Schuurman (1981) has suggested that interregional migration should be used as an additional clustering criterion in a regionalization procedure, because it is a phenomenon with a long time span. If most residential mobility takes place within the functional regions, one may indeed expect that the delineation of these regions will not change much over time.

The last part of this section will be devoted to regionalizations used in regional labor market modeling. We will base the discussion on a recent survey of multiregional economic modeling (Issaev *et al.* 1982), which covers fifty operational multiregional economic models (forty of them including multiregional labor market submodels) from twenty countries. We found a definite tendency to use a general-purpose regionalization consisting of administrative regions. Only in two or three cases did researchers develop a special-purpose regionalization based on the homogeneity principle. In four cases use was made of a general-purpose regionalization based on the functionality principle.

These findings indicate that in general the regional detail in the data base is weak: model builders are forced to use general-purpose regionalizations based on administrative regions. From the modeling point of view, functional regions are preferred for most purposes, however. The insufficiency of regional detail is also shown by the number of regions distinguished in the models: the median number of regions is only nine.

Table 1 reveals that although some models produce information on large numbers of regions, the large majority deal with a relatively small number of regions. Obviously, one should be careful when interpreting these results, since the models pertain to countries that differ greatly in size and population.

Table 1 Frequency distribution of the number of regions in multiregional economic models (source: Issaev *et al.* 1982).

Number of regions	Number of models
2–8	21
9–20	13
21–100	13
>100	2
Unknown	1

In some of the models a multilevel approach is used. In these models economic and labor market phenomena are dealt with at a certain regional level, after which urbanization and land-use phenomena are taken into account at a lower regional level (Rietveld 1982).

3. Statistical Data on Regional Labor Markets

3.1. *Statistical Data: Desiderata*

The desiderata for statistical data on regional labor markets relate to several aspects of data: contents, availability, frequency of observation, length of time series, reliability, type of regionalization (Section 2), and method of data collection (sampling versus integral observation).

An important requirement concerning the contents of a data system is that the data should be *coherent*. For a time series of one particular variable, coherence means that observations at different times are comparable. Hence, no substantial changes in definitions, classifications, counting conventions, procedures to reduce observation errors, etc. may occur, including changes in basic areal units (Section 2.1).

For a regional cross section of one particular variable, coherence means that observations are comparable among regions, with the same restrictions as above. Problems may arise, for example, if there is insufficient coordination between regional agencies responsible for data collection and manipulation. Coherence may become especially problematic when regional data are collected from different countries.

Coherence of data on a set of variables means that, in addition to the above requirements, the classifications of variables should be standardized and all data should be synchronized. Further, coherence of a data set means that no data on major variables are lacking. In general the larger the number of *ad hoc* assumptions one needs when carrying out an analysis, the smaller the coherence of the pertinent data set.

For example, if one wants to compute regional unemployment rates, and data are available on regional unemployment volumes and the regionally dependent labor force, a problem arises since no information is available on the regionally independent labor force. An *ad hoc* assumption is therefore necessary: if one knows the national independent labor force, the corresponding regional variable can be approximated by using some kind of proportionality assumption.

A coherent system of labor market data includes a complete description of labor supply (including unemployment) and labor demand (including vacancies). Data on the persons and/or positions involved should fit standard classifications with respect to sex, age, nationality, education, occupation, economic sector, wage, number of hours worked, and qualitative aspects of labor conditions. Since we are dealing with *regional* labor markets, data on the places of work and residence should also be available. Figure 2 represents supply and demand on the labor market (Central Bureau of Statistics 1977), and indicates that there are two units of observation involved: persons and positions. In Section 3.2 we will discuss some of the problems arising from this fact.

The type of information needed may change from time to time, depending on the conditions of the labor market, which sometimes change rapidly. For special purposes, the standard classifications of data may have to be refined, or new items may be added. For example, in recent years there has been a growing interest in informal, unpaid, "grey" and "black" activities on the labor market, which are usually not covered in labor market information systems.

For an appropriate understanding of the labor market, stocks, such as employment and unemployment, are clearly important. In addition, knowledge of flows is necessary for understanding the dynamics of the

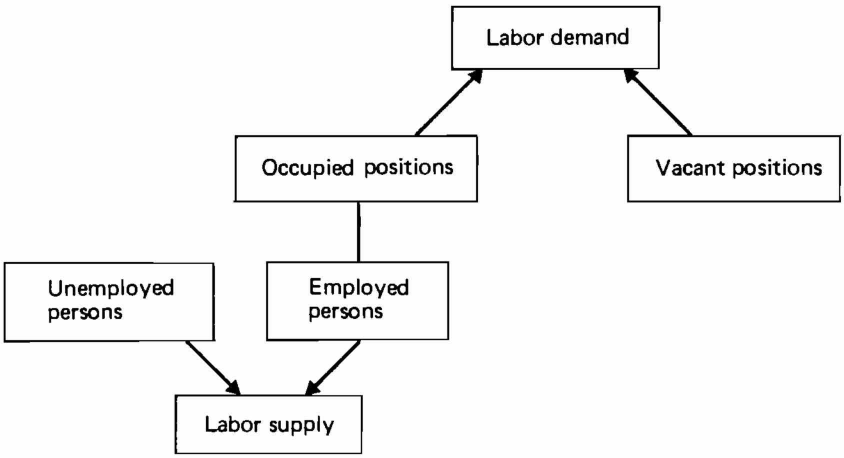

Figure 2 Supply and demand on the labor market.

market. Examples of such flows are: the flows of persons entering and leaving the market, changing positions, becoming unemployed, and moving from one region to another (Heyke *et al.* 1975).

Labor markets are strongly influenced by demographic and economic (industrial) conditions, as well as by the structure of educational and social welfare systems. Therefore, attention should be paid not only to the internal coherence of a system of labor market data, but also to the external coherence with other systems. Ideally, data systems from various fields should be standardized, which would mean that standard classifications for education, occupation, sector, region, etc. should be used in each data system.

As indicated at the beginning of this section, desiderata may not only be formulated with respect to the contents of data. The urgency of these desiderata depends on the purpose for which one wants to use the data. In research there is a great need for coherent data on time series of an acceptable length and measured with an acceptable frequency for modeling purposes. On the other hand, for policy making coherence is not of prime interest; instead, the greatest need is for recent data on key variables.

3.2. *Statistical Data: Practice*

Existing systems of labor market data clearly lack many of the desired features. Often, several elements of the desired data are missing or only weakly developed: data on vacancies, flows, qualitative aspects of labor conditions, and (not surprisingly) informal labor. Also, if data are available, coherence problems of several kinds usually occur. We will illustrate these difficulties by means of the Dutch labor market data system.

The Central Bureau of Statistics in the Netherlands has developed a labor market data system that consists of forty components (CBS 1977). These components range from the census, which is in principle carried out every ten years, to unemployment data, which are produced monthly. The subjects covered by these components are described in Table 2. A considerable number of components (34) relate to total employment or employment in particular sectors. In each of these components one or more of the following aspects of employment are covered: demographic, socioeconomic, sociopsychological, and flows (e.g. commuting and migration). Most data refer to demographic and socioeconomic variables; data on the other two kinds of variables are rare.

Table 2 Subjects of components of labor market data system.

Subject	Number of components
Employment (total)	16
Employment (by sector)	18
Unemployment	4
Vacancies	2

The spatial detail varies among the components. In ten cases data are collected at the national level: a regional disaggregation is not possible. There is also a coherence problem, because in some components a regionalization is used that is not commensurable with regionalizations used in other components.

The diversity among the components of the data system is shown by Table 3, in which the components are characterized by regional detail, the period between successive observations, and the number of attributes covered. In the table we have included the components describing total employment, except for five components based on estimates or of irregular periodicity.

Table 3 Features of total employment components of labor market data system.

Component	Spatial unit	Period between observations	Number of attributes
A	Municipality	10 years	18
B	Municipality	10 years	6
C	Municipality	6 months	4
D	County	2 years	21
E	Province	3 years	10
F	Province	6 months	11
G	Province	1 month	3
H	Nation	1 year	4
I	Nation	2 months	4
J	Nation	1 month	6
K	Nation	1 month	3

This table clearly indicates the complementary character of the components: some of them (A,D,E) combine high regional detail and a broad coverage with a low frequency of observation. Other components (G,I,J,K) have a high frequency of observation but low regional detail and a low coverage of attributes. The latter components have usually been devised for special purposes: they contain data on specific aspects of employment such as wages, overwork, and accidents.

We conclude from the table that regional detail and the number of attributes covered are both negatively correlated with frequency of observation. A positive correlation is found between regional detail and the number of attributes covered.

Ideally, the components of the data system should be used jointly for the analysis of labor market problems. In practice, however, there is often insufficient coherence for this to be possible. Differences in the definitions, classifications, and counting conventions used are considerable.

Figure 2 reveals one source of incoherence in data systems for regional labor markets. The two basic units of observation, persons and positions, correspond to two different sources of data: households and firms. When one examines employment from the viewpoint of positions one will probably find other figures than when it is studied from the viewpoint of persons. One reason for this is that the region of work does not necessarily coincide with the region of residence. Further, certain groups of firms may be overlooked in data collection. Some kinds of part-time work (e.g. when two persons occupy one position) may also give rise to differences.

Coherence problems also arise when the number of vacancies is compared with the number of unemployed. In the Netherlands the unemployed persons and the vacant positions are registered by regional labor market offices. It is advantageous for unemployed persons to be registered, since registration entitles them to unemployment benefits. A similar advantage does not exist for firms when reporting their vacancies. Therefore, one may expect a tendency for the real number of unemployed to be overestimated while the real number of vacancies is underestimated. In this situation it is questionable to use the number of unemployed persons minus the number of vacant positions as a measure of excess supply on the labor market, because of the lack of coherence of statistical data on labor supply and demand.

4. Multiregional Labor Market Models

4.1. *Models: Desiderata*

Ideally, information systems should deal not only with description of the present and the past, but also with description of the future. Thus, information systems should include tools to produce forecasts and impact assessments. For example, extrapolation methods may prove to be useful.

In this section we will focus on the use of multiregional labor market models to produce the desired results.

Which desiderata can be formulated for such models? The answer again depends on the aims of the users. One group of desiderata relates to the kinds of outputs such models should be able to produce. The models should produce results on a number of key variables such as employment, unemployment, and vacancies. They should include features to permit policy analyses. Moreover, the results should be of sufficient detail (both sectoral and regional). Finally, the models should produce results for the appropriate time periods (short, medium, or long run).

Another group of desiderata is concerned with the quality of these outputs, which depends on the quality of:

(1) the model (specification, estimation, and validation);
(2) the data used for the estimation;
(3) the predictions of exogenous variables (used as inputs for forecasts or impact assessments).

We will now pay special attention to the way in which multiregional labor market models have to be specified. The first desideratum is that such models have an integrated structure. They should also take into account demographic and economic developments, as well as educational and social welfare systems. This means either that integrated models have to be built to cover these fields simultaneously, or that separate, connectable models are built for each field.

The second desideratum for labor market models is that they should incorporate interrelationships between regions and sectors. Neglect of such interdependences may give rise to unsatisfactory model output.

The third desideratum is that both supply and demand are included in the models. In addition, various adjustment mechanisms should be specified to deal with market disequilibria: wage adjustments, commuting, migration, entry to and exit from the market, unemployment, interregional relocation of investments, and vacancies.

4.2. *Models: Practice*

For a description of multiregional labor market modeling in practice we will again use the international survey conducted by Issaev *et al.* (1982). First, we will discuss the extent of integration of the models. Figure 3 indicates the extent to which labor market models also include economic and demographic submodels. Nineteen of the forty multiregional labor market models are completely integrated. Of the rest, 18 models are partly integrated, while three others are not integrated at all.

Another finding of the survey is that the education and social welfare systems are usually neglected or only treated in a superficial way. We may conclude, therefore, that multiregional labor market models on average do not reach a high level of integration.

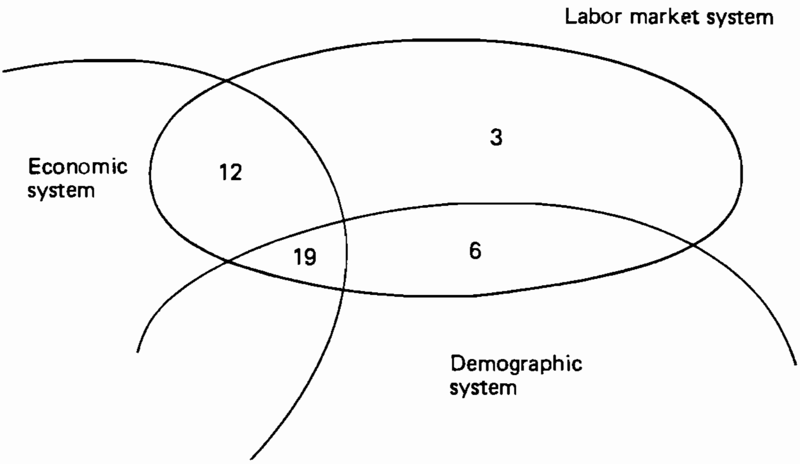

Figure 3 Scope of multiregional labor market models.

Concerning the treatment of supply and demand, we find that in approximately one-quarter of the models the level of employment is exclusively determined by forces from the demand side. Only two models have a supply-oriented structure. In the majority of cases, employment is determined by both supply and demand. Although it cannot be denied that for certain countries a pure supply or demand orientation adequately represents reality, mixed models will in most cases be more appropriate since they can be used, in principle, in times of slack and of boom.

We find that unemployment plays a role in about half of the models, while vacancies are virtually missing. Therefore, disequilibria are only taken into account in half of the models. Further, it indicates an asymmetric treatment of supply and demand on regional labor markets. The obvious reason for this asymmetry is the lack of reliable data on vacancies at the regional level.

Another crudeness in multiregional labor market models is discovered when one considers the treatment of occupational mobility. When demand and supply are confronted with each other in the models, usually an aggregation is applied over all sectors or occupational categories. This essentially assumes perfect labor mobility across occupations and sectors. Limitations are imposed on mobility in only a small number of models.

Interregional relationships receive much attention in the models. This is true especially for trade, but migration is also frequently included (approximately one-third of the models). In most of the models migration flows function as adjustment mechanisms for regional labor markets. Usually, the basic determinants relate to tensions on the labor market. In some models, however, variables describing the housing market and environmental conditions are the main determinants of interregional migration. In these cases, migration may aggravate rather than improve imbalances at regional labor markets.

As regards the period over which multiregional labor market models produce meaningful results, we find that the medium term (5–15 years) dominates the picture. It appears that almost no models combine a well developed demographic submodel with an adequate model of capital formation, although both components are prerequisites for adequate long-term studies. One reason for this is that data on capital are poor at the regional level. In addition, short-term models are almost absent. The time unit is (with one exception) at least one year, indicating that the frequency of observation of regional data is relatively low (Section 3.2).

Another important aspect of regional data is recency. In the survey we find that the most recent data used are, on average, rather old: at the beginning of 1982, the most recent regional data were from the period before 1975 for one-half of the models. This period is characterized by a rather stable growth pattern compared with the period after 1975. This certainly implies a decrease in the relevance of the models for the problems of the 1980s. It is our impression that this long lag is caused not only by regional data becoming available after considerable delay, but also by model builders themselves, who do not pay sufficient attention to updating their models.

Finally, we will look at the use of multiregional labor market models. On the basis of the above-mentioned survey, we find that the following features favor extensive use:

(1) The model builder is a consultancy or governmental agency.
(2) The model structure is simple (partial rather than integrated).
(3) The regional and sectoral detail is high.

The accessibility of models to users is, in general, low. Only in some cases can the model be used without intervention from the model builder. The number of models with a completely documented user's manual is comparatively low. We conclude that, on average, the potential of models as part of information systems for regional labor markets is only being realized to a small extent. There are some notable exceptions to this conclusion, however. The survey also includes some models that are easily accessible to users (especially regional authorities) through the use of a computerized network. This network can be used not only for the transfer of model output to users, but also for the transfer of basic regional data to the model operators.

5. Conclusion

Information systems for regional labor markets do not in all respects satisfy the desiderata formulated in this chapter. We have indicated various approaches to improve this situation. One step is to improve the statistical data base in accordance with the needs of the users. Several underdeveloped elements of the data base have been mentioned. Another way is to increase the flexibility of the information systems with respect to the regionalizations used. Finally, the possibilities of using labor market models as components of such information systems have not yet been fully exploited.

References

Baumann, J.H., M.M. Fischer, and U. Schubert (1982) A multiregional labor supply model for Austria: The effects of different regionalizations in multiregional labor market modeling. *Paper* presented at 22nd European Regional Science Congress, 23–27 August, Groningen.

Central Bureau of Statistics (1977) *Sociale Maandstatistiek*. Inventarisatie van Statistische Gegevens van het Centraal Bureau voor de Statistiek met Betrekking tot Arbeid, pp. 518–528 (Amsterdam: CBS).

Christaller, W. (1935) *Die Zentralen Orte in Süddeutschland* (Jena: Fischer).

Coombes, M.G., J.S. Dixon, J.B. Goddard, S. Openshaw, and P.J. Taylor (1980) The Standard Metropolitan Labor Area concept revisited. *Developments in Urban and Regional Analysis*, ed. M.J. Breheny (London: Pion), pp. 140–149.

Dalenius, T. (1977) Towards a methodology for statistical disclosure control. *Statistisk Tidskrift* 5:429–444.

Fischer, M.M. (1982) *Eine Methodologie der Regionaltaxonomie*. Bremer Beiträge zur Geographie und Raumplanung, Schwerpunkt Geographie, Universität Bremen, Bremen.

Heyke, J.A.M., L.H. Klaassen, and C.J. Offereins (1975) *Naar een Arbeidsmarktmodel* (Groningen: Tjeenk Willink).

Issaev, B., P. Nijkamp, P. Rietveld, and F. Snickars (eds.) (1982) *Multiregional Economic Modeling: Practice and Prospect* (Amsterdam: North-Holland).

Johnston, R.J. (1970) Grouping and regionalization. *Economic Geography* 46:293–305.

Nijkamp, P., and J.H.P. Paelinck (1976) *Operational Theory and Method in Regional Economics* (Westmead: Saxon House).

Norton, R.D. (1979) *City Life-Cycles and American Urban Policy* (New York, NY: Academic Press).

Openshaw, S. (1978) An optimal zoning approach to the study of spatially aggregated data. *Spatial Representation and Spatial Interaction*, eds. I. Masser and P. Brown (Leyden; Boston, MA: Martinus Nijhoff), pp. 95–113.

Peters, A.B. (1982) Der Verstädterungsprozess in den Niederlanden nach 1950 und seine raumordnungspolitischen Implikationen. *Ph.D. Thesis*, Technical University, Berlin (West).

Rietveld, P. (1982) A general overview of multiregional economic models. *Multiregional Economic Modeling: Practice and Prospect*, eds. B. Issaev *et al.* (Amsterdam: North-Holland), pp. 15–33.

Schuurman, F. (1981) *Regionale Arbeidsmarkten*. Monografien Volkstelling 1971, No. 16 (The Hague: Staatsuitgeverij).

Van Engelsdorp Gastelaars, R. (1981) Regionale statistiek en regionaal sociaal ruimtelijk onderzoek. *Paper* presented at Studiedag Regional Economische Statistiek, Amersfoort, Netherlands.

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CHAPTER 10

Operational Information Systems for the Housing Market

Björn Hårsman

1. Introduction

Residential costs typically constitute 15–20% of household expenditure and hence form one of the largest budget items. Investment in housing is a significant component of the total investment volume and plays an important role in the business cycle. Furthermore, the high ratio of capital to output makes investment in housing vital to economic growth.

The social impacts of housing are also substantial. Its fixed location relative to work places, public and private services, and transportation is an important characteristic. By furnishing not only shelter and various utilities, but also access to jobs and other individuals, for instance, housing has diverse influences on the living conditions of a household.

This short description indicates that housing is important at all socioeconomic levels, from the national to the individual, and that there exist interdependences between housing policy and other policy areas. The aim of this chapter is restricted to discussion of some features of the housing market and their implications for information systems.

There are several reasons for attaching special importance to the regional dimension of information systems for the housing market. The socioeconomic significance of housing, as well as the links between housing and other sectors, makes housing a central issue in regional planning. By region I mean a geographic area where the residents can, without too much inconvenience, change work places without moving and move without necessarily changing work places. According to this definition, excess demand for housing in one region cannot be counterbalanced by excess supply in another region. Hence, regional information must be used in planning at the national level.

At the local level, i.e. areas constituting parts of regions, it is also necessary to consider regional aspects of the housing market. For example, population development at the local level is to a large extent influenced by the demand and supply conditions for the whole region.

Section 2 describes some general aspects of information systems. The relationship between policy and information is discussed and some comments are made on the balance between the information components: models and data. Section 3 tries to give a broad perspective on housing issues, indicating the links between housing policy and other policy areas. The significance of the degree of centralization or decentralization in the planning system is also noted. In Section 4 it is argued that a disaggregated approach should be employed when analyzing housing issues at the regional level. Such an approach is then used to discuss the need for models and data. Finally, some comments are made on the possibility of developing information systems for the housing market. It is proposed that some basic regional elements should be designed to facilitate linkages to information available at the national level as well as to intermittent regional surveys. Module is the key word.

2. General Aspects of Information Systems

Public policy is a prerequisite for the kind of information system I am going to discuss. Although I agree with Nijkamp (1982), for example, on the significance of developments in computers, microelectronics, and telecommunications services for the "information explosion," I believe the expanding public sector and the increasing degree of specialization of labor have been the main driving forces behind this explosion. In the OECD countries the median share of national income devoted to public expenditure increased from 31 to 52% between 1950 and 1974 (Nutter 1978, p.4). This development means that the public sector has become more influential than the private sector as a provider of goods, services, and income supplements. A private market may be more or less competitive and the organization of public activities may be more or less decentralized, but it seems safe to conclude that an expanding public sector increases the level of centralization in an economy. If knowledge is assumed to be decentralized this automatically results in an expanding demand for information handling.

As outlined in Figure 1, public policy of course presupposes management and planning, and neither of these activities can be performed without information. There is also a need for information that can be used to control the policy pursued. The control is needed both from a democratic point of view and in order to scrutinize the effectiveness of public management and planning. The figure also indicates that information may be seen as being produced from models and data. This is in accordance with the views of Nijkamp (1982) and, like him, I regard information as data that have been refined in some way, such as through modeling.

Figure 1 may be used as a starting point for some further observations. The first is that the degree of centralization in the public sector

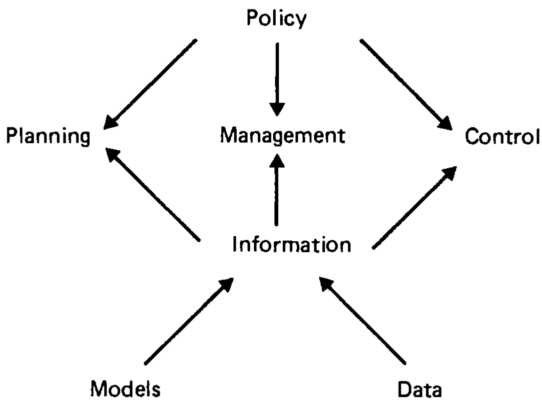

Figure 1 Links between public policy and information.

plays a crucial role. The more important the local and regional levels compared with the central level, the greater the need for a regional information system. Information about the general trend in this respect is unfortunately both fragmentary and unreliable, but the evidence at hand indicates an increasing degree of decentralization (Nutter 1978, p.92). According to Nutter, it is at least safe to conclude that central governments in the OECD countries are not the cause of a growing share of total government expenditure since 1950.

In Sweden the trend is clear-cut. Since 1860 the share of public consumption accounted for by local governments has increased from roughly 30% to more than 70%. However, this trend has not been adequately reflected in the information systems. Modeling efforts are more frequent at the national level and, according to Guteland and Nygren (1982), only 6% of the budget for the Swedish National Bureau of Statistics is allotted to regional and local data, representing a clear imbalance.

Another observation based on Figure 1 is that the design of planning, management, and control exerts a strong influence on the demand for information. Figure 2 illustrates this point in a striking way. It should be pointed out that increased adaptability does not necessarily imply a reduction of the need for information. In this example adaptability presupposes knowledge of alternative production possibilities and in general there is probably a trade-off between various information components.

Finally, some comments should be made on the balance between models and data. At one extreme we have those arguing that data should "speak for themselves" and that good intuition is the only model needed. On the other hand, the professional model builders argue that theoretical rigor and explicit consideration of different factors are prerequisites for good decisions. Neither group seems to have paid due attention to the

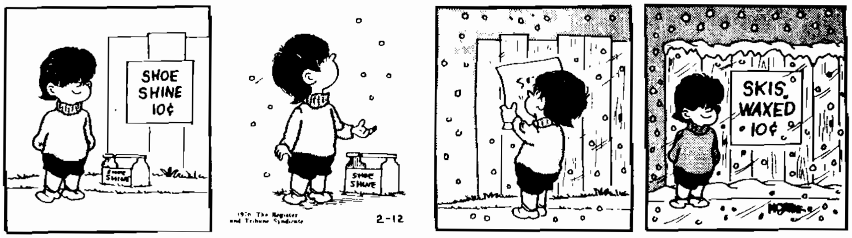

Figure 2 Adaptability instead of a forecast (source: Armstrong 1978, p.7; reproduced by permission of John Wiley & Sons, Inc., New York). © 1970 The Register and Tribune Syndicate.

psychological research into these matters, which clearly demonstrates our limited ability to handle information and to make decisions. According to Magnusson (1978) this inability is one of the most fundamental factors governing our behavior. A lot of experiments support the proposition. For example, Tversky (1974) has shown that we have a tendency to use irrelevant information and Magnusson (1978) that we use only a small part of the information available. In fact a lot of studies have demonstrated that we can handle only a few factors at the same time and find it difficult to integrate various pieces of information. Other studies have demonstrated our inability to apply consistent judgment to a repetitive set of cases, and to judge probabilities or make risky choices in an objective way (e.g. Dawes 1971, Kahnemann and Tversky 1982). Furthermore, numerous studies show that quantitative models may perform better than the intuitive predictions of experts (reviewed by Armstrong 1978).

A major conclusion is that findings of this kind must be considered when designing information systems. Another conclusion is that the principle of letting data speak for themselves has a high (subjective) tendency to lead one astray. Obviously, we need models to compensate for shortcomings in acquiring and processing data. The third conclusion is based on the fact that most of us can cope with the complicated decisions involved when driving a car or playing table tennis: when decisions have to be made frequently and the time between decision and result is short, it is evidently possible to overcome the reported shortcomings. Hence, our modeling efforts should be greatest when working with infrequent decisions. And we should include a record of decisions in our information systems, which should be used for successive improvements of the models in the system.

Another aspect of the balance between models and data is illustrated by Figure 3. The vertical axis represents errors due to model specification and measurement errors, while the complexity of the model is measured along the horizontal axis. The broken curve shows that the specification or model error may be assumed to decrease as the complexity of the model increases. The dotted curve indicates that the measurement error caused by errors in input data increases with model complexity.* The full curve, representing the total error, demonstrates that there is an optimal balance between modeling efforts and quality of data.

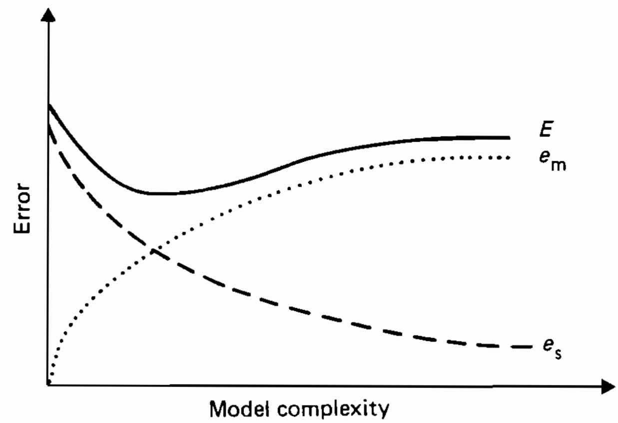

Figure 3 Total error E due to measurement errors e_m and errors of specification e_s (source: Alonso 1968).

3. Links to Other Policy Areas and Other Subsystems

It is essential that information systems for a regional housing market reflect the interdependences between housing policy and other policy areas, as well as between various geographic levels. As illustrated in Figure 4, housing policy interacts with almost all major policy areas.

The links to general economic policy stem from two important characteristics of housing: its high capital cost and its great durability. The balanced rate of growth in an economy depends upon the total investment share. The rate of growth also depends upon the capital:output ratio, which differs systematically between the housing sector and other sectors, being much higher in the housing sector. This implies that the share of the total investment allocated to housing significantly affects the rate of growth. This is illustrated in Figure 5.

Both curves show that there is a trade-off between the rate of growth and housing investment: the higher the share of investment accounted for by housing, the lower the balanced growth rate.** The upper curve

* Let us assume a model $z = f(x_1 \cdots x_m)$. The usual equation for the output error resulting from propagation of errors in the inputs is

$$e_z^2 = \sum_i f_{x_i}^2 e_{x_i}^2 + \sum_i \sum_j f_{x_i} f_{x_j} e_{x_i} e_{x_j} r_{ij} \quad .$$

where e_z is the error of z, f_{x_i} is the partial derivative of f with respect to x_i, e_{x_i} is the measurement error in x_i, and r_{ij} is the correlation between x_i and x_j.

** In the long run the importance of the difference in capital:output ratios will be reduced. Moreover, housing investments may stimulate growth when resources are not fully utilized.

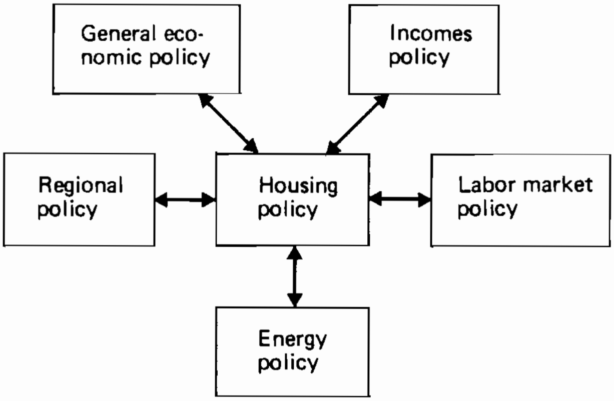

Figure 4 Links between housing policy and other policy areas.

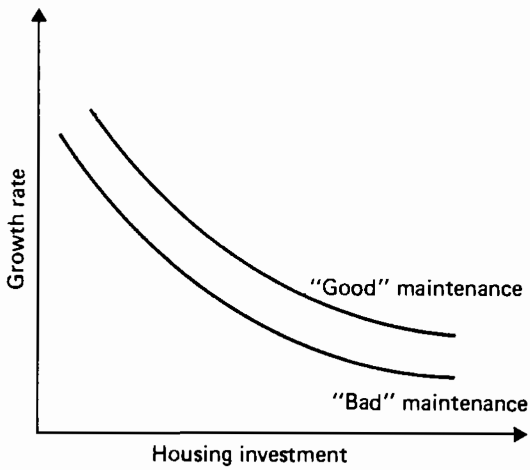

Figure 5 The relationship between rate of growth and housing investment.

represents a higher level of maintenance. The two curves demonstrate that good maintenance of the housing stock may mitigate the conflict between growth rate and investment in housing.

The extreme durability of housing gives rise to cyclical problems. Even rather small changes in the demand for housing cause large changes in the demand for investment in housing. In such cases a free market tends to create a cyclical investment pattern, which may destabilize the whole economy. The problem is further illustrated in Figure 6.

In the short run the supply of dwellings is fixed. Demand, on the other hand, may change considerably, in terms of both level and composition. The figure illustrates the effects of an income increase. If prices are fixed, e.g. through administrative rules, there will be an excess demand for

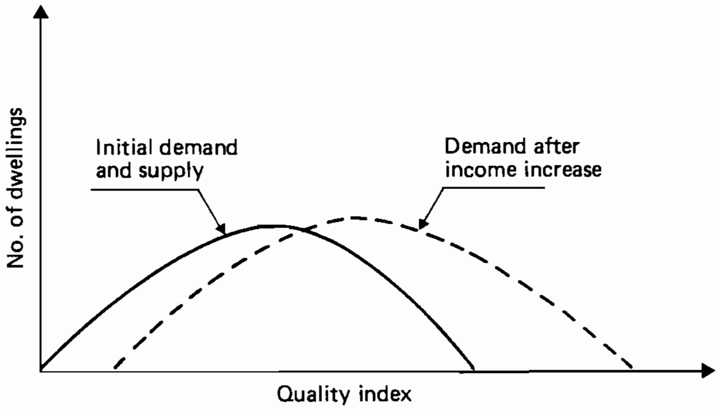

Figure 6 Imbalance in the housing market caused by income increase.

high-quality dwellings and an excess supply of low-quality dwellings. If the market is free it is evident that prices, as well as investments, will tend to fluctuate sharply.

A reduction of the cyclical fluctuations in housing investment helps to reduce fluctuations of the whole economy. It is also closely tied to the general goal of efficiency in the use of resources, because stability holds out hopes for gains in productivity. There are also links to labor market policy. Housing construction is labor-intensive compared with many other types of production. Therefore, variations in the demand for housing investment will cause comparatively large disturbances in the labor market. In addition, elements of industrial mobility in the labor market policy tend to increase housing demand. Since the location of housing is fixed, such a policy will increase the demand for housing investment to the extent that net migration between different labor markets is increased.

There are also interactions between housing policy and the taxation of property, income, and capital gains. A recent Swedish study by Englund and Persson (1981) may serve as an example. It indicates that house prices are strongly affected by changes in the marginal tax rate. In Sweden, as in many other countries, the imputed rent from owner-occupied housing is taxed at a much lower rate than capital income from other sources. The imputed rent is usually fixed and, at the same time, the interest paid on loans for the house is fully deductible. High nominal interest rates and marginal tax rates therefore make owner occupation attractive.* By simulation, Englund and Persson show that the increased progression of the Swedish tax schedule during the 1970s may have increased the average price of single-family houses by around 30%.

* Another consequence is that it is more expensive for households with low incomes than for households with high incomes to live in houses of their own. This result is not in accordance with the general incomes policy.

Another often neglected link between housing and income refers to interregional differences in real income. As illustrated in Figure 7, a housing policy with elements of rent control may favor households living in large regions. The influence is undesirable because households in large agglomerations usually have higher incomes than households in small regions.

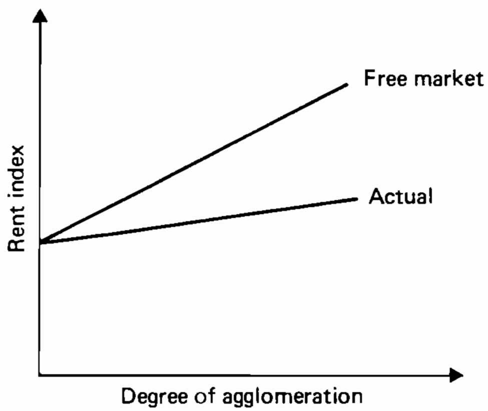

Figure 7 Difference between actual (controlled) rent structure and the probable equilibrium structure.

Let us now turn to intraregional interdependences between housing and other subsystems. As indicated in Figure 8, there are important links between the housing, transportation, work-place, and utility systems. According to the figure, land use is the common denominator in the long run. In the medium-term perspective various sectoral dependences are of central interest; the focus may be shifted from the dynamics of building stocks to processes within the built-up stocks. The short-term perspective may be oriented toward commuting, service trips, and flows of goods and information. In all perspectives it is important to study the interaction between various balancing forces, for example between relocation of work places and the rent gradient for housing, between price changes in the housing market and relocation of households, and between relocation of households and commuting.

It is also important to note the influence that the housing market exerts on income and population at the local level, since they are of fundamental importance to local policy. Furthermore, they are essential factors at the regional level insofar as segregation is considered to be an important aspect of regional policy.

According to this discussion, regional information systems for housing should be capable of the following functions:

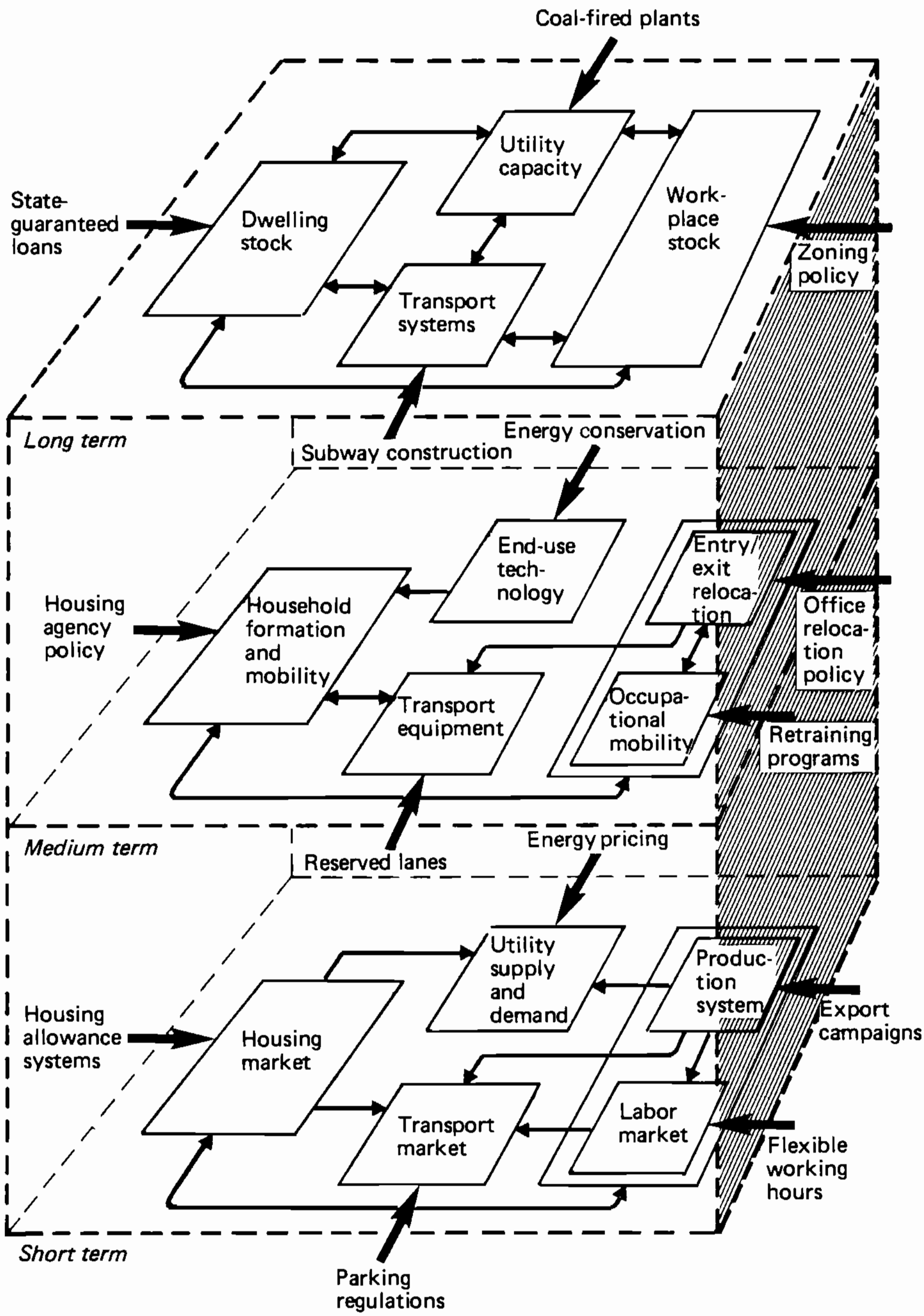

Figure 8 Connections between urban subsystems over different time perspectives, and some examples of public policy measures (source: Snickars *et al.* 1982).

- to handle housing investments and the relationships between housing investment, economic growth rate, economic stability, and labor demand;
- to keep track of changes in national housing policy, incomes policy, labor market policy, and regional policy;
- to take into account various links at the regional level between the housing sector and the transportation, work-place, and utility systems;
- to make it possible to analyze the development of population and income at the local level.

The major aim of information systems for a regional housing market is of course to support regional and local housing policy. This will be discussed next.

4. The Housing Market

During the seventies numerous studies stressed the importance of disaggregation in analyzing a housing market. The comprehensive empirical and theoretical studies carried out by the National Bureau of Economic Research in the United States can be mentioned as an example (Ingram *et al.* 1972, Straszheim 1975, Kain and Quigley 1975). According to Kain and Quigley (1975, p.1), the NBER research shows clearly that "the demand for housing and the behavior of urban housing markets are better understood if housing is viewed as bundles of heterogeneous housing attributes rather than as a single-valued commodity, housing services."

As indicated by Figure 9, it is equally important to distinguish between different household categories. Apart from income and household size, education and age are among the factors that should be considered (e.g. Andersson 1975).

From a policy point of view, a micro-oriented approach is equally important. Several policy goals are connected with consumption patterns. To equalize the distribution of housing consumption, to obtain a reasonable relationship between rent and income, and to counteract segregation are some Swedish examples. The policy instruments work on both the demand and the supply side. Different measures are often used for different household categories or dwelling types. Special housing allowances for old-age pensioners and real-estate taxes linked to the age of the building are two Swedish policy instruments of this kind.

Figure 10 gives a rough picture of some basic elements that should be considered in an information system. The basic data on the demand side describe population, income, households, and demand for various dwelling types. Household formation models and demand models are needed. On the supply side, data on the stock of dwellings are essential. Data and models concerning investment, rebuilding, and maintenance are also important. In the housing market demand is confronted with supply. The

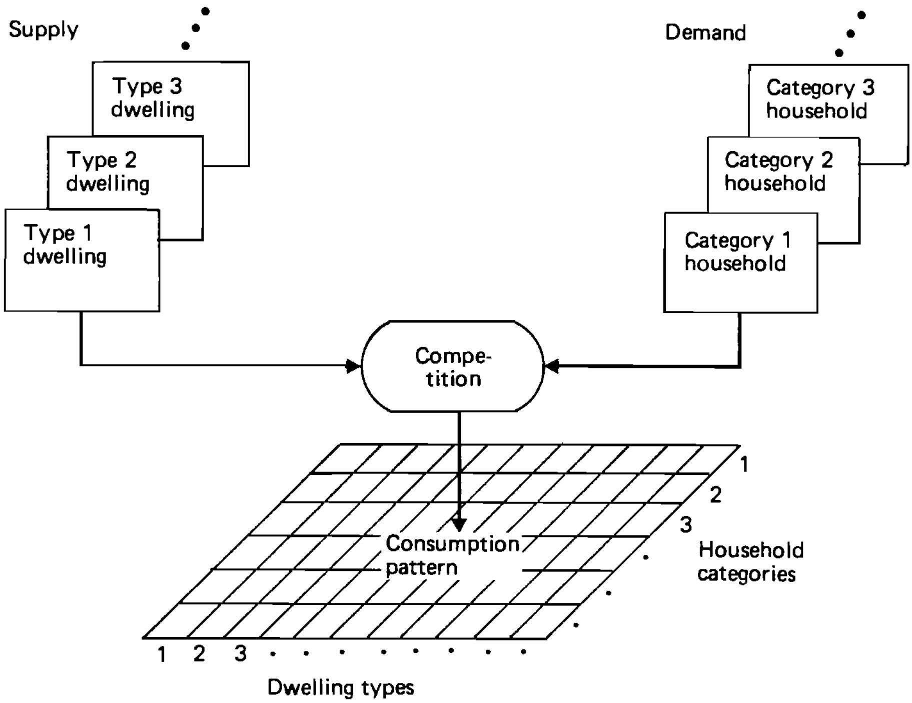

Figure 9 The proposed perspective for a housing market information system.

resulting market signals are fed back into the system both directly and in the form of policy measures.

On the demand side, the need for disaggregation makes it necessary to model the household formation process. The tools available are, broadly speaking, demographic models and economic models. The demographic models, such as the headship rate method, are often self-contained insofar as economic and social factors are seldom used explicitly. In economic models demographic factors are often treated in a superficial and highly aggregated way (e.g. Du Rietz 1977).

Usually, the data on household formation are incomplete. In Sweden, the data available may be characterized as relatively detailed as regards stock information, but defective as regards flow information. There is considerable information about cross-section conditions at different times, but one may only rarely obtain data describing changes between these times.

One conclusion is that there is a strong need for models that make it possible to reconcile demographic and economic factors (e.g. Hårsman and Scheele 1982). It is also important to arrange data on population and households in such a way that information on fertility, mortality, marriages, and divorces can be tied not only to individuals (as is the case in several countries) but also to households.

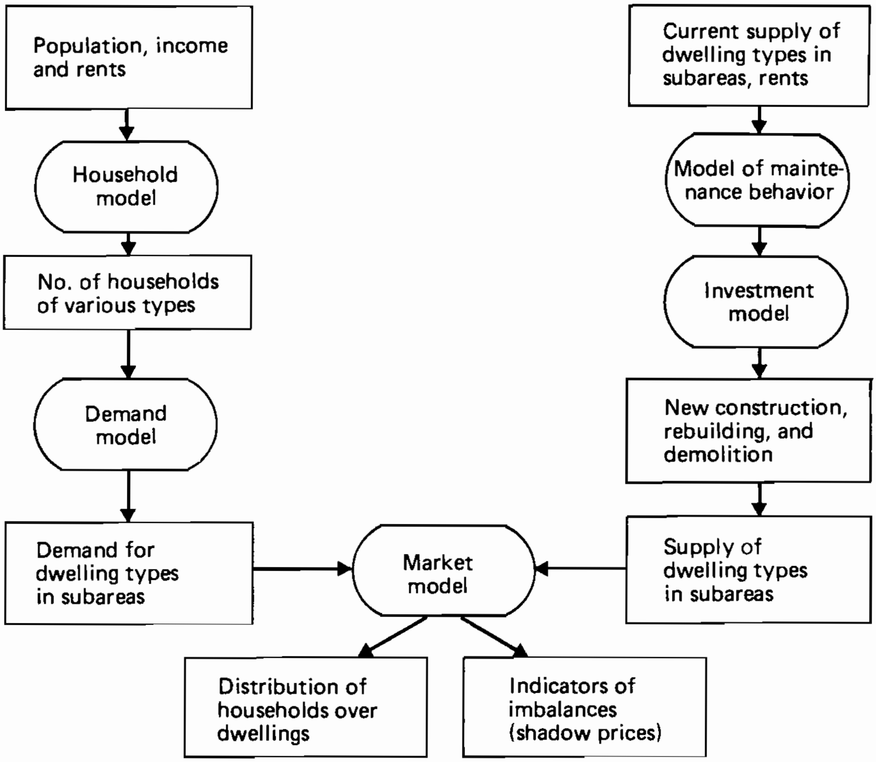

Figure 10 Some basic components of an information system for the housing market.

Demanding a certain type of dwelling corresponds to demanding a certain set of characteristics that refer not only to the dwelling but also to the environment. By virtue of the fixed locations of dwellings, work places, and transportation facilities, the choice of residence determines access to work and services as well as to other dwellings, i.e. other households.

The importance of different attributes has in recent years been studied by, among others, Wilkinson (1973), Kain and Quigley (1975), and Leven *et al.* (1976). Kain and Quigley came to the conclusion that attributes relating to quality, such as general conditions of dwelling and building, had as much influence on the dwelling price as had the number of rooms, the standard of equipment, and other quantitative variables. Wilkinson does not draw any decisive conclusions, but he shows that attributes associated with the neighborhood of the dwelling may have a stronger influence on the price than attributes directly associated with the dwelling. Leven *et al.* show that the socioeconomic characteristics of households in the neighborhood have a great impact on the price.

This means that data on the housing stock should comprise both dwelling and neighborhood attributes. Different forms of tenure as well as location should also be distinguished. Furthermore, Leven's findings underline the importance of classifying households according to characteristics such as education and profession.

There are already several demand models available that handle housing demand as a demand for a set of attributes. However, most of them are of a static type. The importance of moving costs (Hårsman 1981, Wise 1982) calls for a dynamic orientation in modeling.

On the supply side, great importance must be attached to institutional factors. This of course applies to both data and models. The investment data should comprise both building costs and total production costs, and the data on housing stock should inform not only on costs of maintenance but also on capital costs, as well as costs of fuel and electricity.

The kinds of models and data needed to study the consumption pattern and the impact on this pattern of various demand and supply measures depend upon the market-clearing process. If prices are controlled, totally or to some extent, data on consumption may give wrong information about the demand. This is illustrated by Figure 11. Some of the households demanding a dwelling of type i may live in a dwelling of type j, and some of the households in dwellings of type i may demand dwellings of type j. As a result, consumption data will misinform us about demand. In terms of Figure 11, we obtain data on column totals instead of row totals.

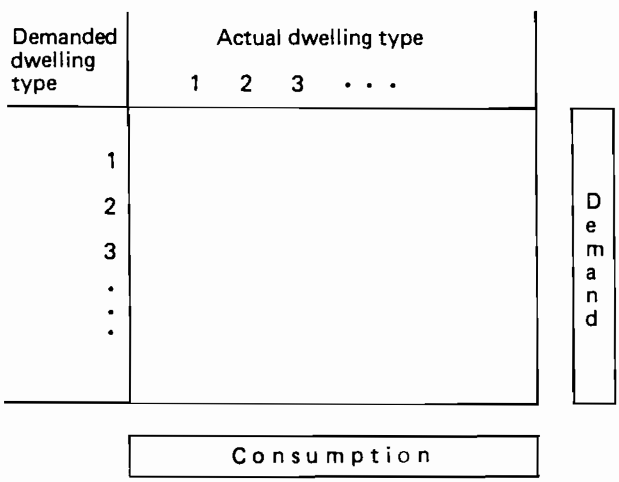

Figure 11 Differences between housing consumption and demand.

The inertia of the housing market contributes to the difference between consumption and demand. Even in a free market it is improbable that demand and supply are always in balance. To change the housing stock takes time and there is reason to believe that demand and price changes are also relatively time-consuming.

The adjustment between consumption and demand may be rather complicated. It is probable that some households move and adjust their consumption before rather than after certain events. Anticipating a future increase in income or household size and considering the cost of moving, a household may well prefer to move to a dwelling that is too large for its immediate needs instead of moving successively to incrementally larger dwellings as its space requirements grow.

One way to handle the long-term aspects is to use permanent instead of current income in the demand models. However, there is no self-evident way to define and measure permanent income, and it seems better to model moves and moving costs explicitly. Whichever approach is chosen there is a need for demand data. In countries with controlled rents this poses a problem. One possibility is to seek direct information on the demand by means of carefully designed interviews with a sample of households. Gustafsson *et al.* (1977) have demonstrated that such a technique can be used to estimate a household's bid prices for various dwelling types.

In the discussion above it has been argued that modeling efforts should be focused on the supply side and on various adjustment processes, i.e. on working out dynamic models. It has also been suggested that a consumption pattern matrix should be used as a starting point for the development of data on households and housing stock. When designing such data, one should try to obtain links to flow data regarding population and investments. It was also suggested that interview techniques should be used to investigate demand in markets with controlled rents.

5. Concluding Remarks

An important discovery in psychological research is that we are less capable of handling data and probabilities than usually assumed. Several experiments have shown that simple quantitative models of the objective kind often perform better than intuitive decision making. In countries like Sweden this calls for an orientation toward modeling in information systems. In other countries the marginal benefits of data production may be much higher. When data are unavailable or inadequate, one possible strategy is to introduce a few basic data sets. In Sweden the censuses constitute one such basic set of data on the consumption pattern.

The growth of the public sector and the increased decentralization within that sector are important arguments for increased production of data at regional and local levels. Data are needed in both management and planning and to facilitate controls by various decision makers. One way to obtain regional or local data is to increase the availability of data officially recorded at the national level. Another is to design national surveys so that it is easier to use the results at a regional level. One should also consider the possibility of linking various data gathered at regional and local levels to official data. Again, the importance of common denominators should be stressed.

To capture in one information system all the complexities of the housing market and the links between housing and other systems and policy areas is of course not possible. It is not even desirable. Several different information systems are needed, but we should try to design them in such a way that they can be connected. The same conclusion is valid for each such information system. For example, an information system concerned with housing demand should comprise several small models and several small data sets rather than one large model and one large data set. Not only would such a module-oriented approach make an overview of the information systems possible. It would also facilitate a successive and continuous expansion of these systems, an expansion that is balanced with regard to models and data as well as to marginal costs and benefits of information.

References

Alonso, W. (1968) Predicting best with imperfect data. *AIP Journal* 36(4):248–255.

Andersson, Å.E. (1975) Merit goods and microeconomic dependence. Public Economics and Human Resources, *Proceedings* of 31st Congress of International Institute of Public Finance, Nice.

Armstrong, J.S. (1978) *Long-Range Forecasting: From Crystal Ball to Computer* (New York, NY: Wiley–Interscience).

Dawes, R.M. (1971) A case study of graduate admissions. *American Psychologist* 26:180–188.

Du Rietz, G. (1977) Determinants of housing demand – Analysis of census data for the county of Stockholm, 1970. *Scandinavian Journal of Economics* 79(3):312–325.

Englund, P., and M. Persson (1981) Housing prices and tenure choice with asymmetric taxes and progressivity. *Research Paper* 6212, Economic Research Institute, Stockholm School of Economics.

Gustafsson, J., B. Hårsman, and F. Snickars (1977) Housing models and consumer preferences: Applications for the Stockholm region. *Papers of the Regional Science Association* 38:125–147.

Guteland, G., and O. Nygren (1982) Information systems for integrated regional planning and policy making. *Paper* presented at Workshop on Information Systems for Integrated Regional Development, International Institute for Applied Systems Analysis, Laxenburg, Austria, 15–17 December.

Hårsman, B. (1981) Housing demand models and housing market models for regional and local planning. *Report* D13:1981, Swedish Council for Building Research, Stockholm.

Hårsman, B., and S. Scheele (1982) Household projections with a reconciliation of demographic and economic factors. *Paper* presented at Demographic Symposium, Kungälv, Sweden, June.

Ingram, G.K., J.F. Kain, and J.R. Ginn (1972) *The Detroit Prototype of the NBER Urban Simulation Model* (New York, NY: Columbia University Press).

Kahnemann, D., and A. Tversky (1982) The psychology of preferences. *Scientific American* 246(1): 136–142.

Kain, J.F., and J.M. Quigley (1975) *Housing Markets and Racial Discrimination* (New York, NY: Columbia University Press).

Leven, C.L., J.T. Little, H.O. Nourse, and R.B. Read (1976) *Neighborhood Change. Lessons in the Dynamics of Urban Decay* (New York, NY: Praeger).

Magnusson, D. (1978) Den mänskliga begränsningen. *Report* 20, Psychological Institute, University of Stockholm.

Nijkamp, P. (1982) Information systems for multiregional planning. *Collaborative Paper* CP-82-27, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Nutter, G.W. (1978) Growth of government in the West. *Report*, American Enterprise Institute for Public Policy Research, Washington, DC.

Snickars, F., B. Johansson, and G. Leonardi (1982) Nested dynamics of metropolitan processes and policies. *Draft Project Description*, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Straszheim, M.R. (1975) *An Econometric Analysis of the Urban Housing Market* (New York, NY: Columbia University Press).

Tversky, A. (1974) Assessing uncertainty. *Journal of the Royal Statistical Society* B 36:148–159.

Wilkinson, R.K. (1973) House prices and the measurement of externalities. *The Economic Journal* 83:72–86.

Wise, D.A. (1982) Moving and the demand for housing: Fixed costs and disequilibrium. *Paper* presented at Workshop on Spatial Choice Models in Housing, Transportation, and Land Use Analysis: Toward a Unifying Effort, International Institute for Applied Systems Analysis, Laxenburg, Austria, 29 March to 1 April.

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CHAPTER 11

Multiregional Modeling and Statistical Information

Raymond Courbis

1. Information Requirements for Multiregional Modeling

Since the beginning of the 1970s, several multiregional models have been built (a survey has been made by Issaev *et al.* (1982)). These models show a greater variety in structure than do national models. The general purpose of these models – simulation or forecasting, calculation of the regional impacts of national policies, and integrated analysis of interdependences between regional and national development – explains partly such differences. But statistical problems also can explain the specifications or general structure of a particular multiregional model.

Statistical problems are indeed more important for multiregional (and regional) models than for national ones. In general, there are no problems for such regional variables as employment and unemployment, and one can understand why such variables are introduced (or are considered alone) at the regional level. However, the regional information required for building a multiregional model depends on the type of model.

1.1. *Interregional Input–Output Models*

Interregional input–output models, such as the Polenske (1980) model for the US economy, emphasize the relations that exist between regions through interregional flows of products. The flows are determined by regional propensities to export or import or by using a gravity-type model.* In these multiregional models (Polenske 1980) regional final

* A few multiregional input–output models introduce not interregional linkages but, as proposed by Leontief (1953), relationships between regional production and national demand. One assumes a "national" market with given shares for the producers of each region.

demand is most often calculated very simply by allocating the total national demand among the regions, on the basis of exogenous shares.*

Nearly all such models are not econometric ones (though there are exceptions, such as the model built for Japan at the Mitsubishi Research Institute (Suzuki *et al.* 1973/1978)): technical coefficients are exogenous and one only has to introduce relationships for interregional flows. Consequently, it is only necessary to have data (more precisely, an interregional input–output table) for one year; or for a few years, allowing for extrapolations of structural coefficients. If interregional flows are calculated on the basis of propensities to export or import, such statistical information is sufficient. If a gravity approach is used the parameters can also be estimated, for medium- or long-term projections, by a cross-sectional method (pooling time series and interregional data would improve the econometric estimation).

From a statistical point of view, the main problem is data on interregional flows. Generally, the basic information comprises statistics on interregional transportation by commodity group and transportation mode. The reader is referred, for examples, to Polenske (1980) for the US, and to Courbis and Pommier (1979) for France (for which direct data have been available for some products). Special enquiries are also made, such as for Canada (or at a regional level).

1.2. *Pure Top-Down (Multi-)Regional Models*

Top-down models, as proposed by Klein (1969), directly connect the values of regional variables to national figures. They assume that regional development is dependent upon the national economy and that the region is sufficiently small to have no significant impact on national development. No direct relationships with other regions are introduced.

Such models are quite simple, but since they assume a dichotomy between regional and national development they can only be used for analyzing the impact of the national economy upon a region or for making a regional (or multiregional) forecast consistent with a national forecast that one does not wish to reestimate (e.g. because a national model is considered as more reliable).

The interest of top-down models from a statistical point of view is that statistical requirements are not too important. As national-to-regional linkages are introduced, it is possible to consider reduced forms, and, thus, to adapt the specification and choice of regional variables to the availability of regional data.

* Some multiregional input–output models are "closed" but the relationships are quite simple: one assumes that regional consumption by product is a given share of total consumption, the latter being itself a given share of total household income. For calculating household income one only considers that, for each industry, distributed income is a given share of value added.

1.3. *Integrated Regional–National Models*

Integrated regional–national models, on the other hand, can be used not only for regional forecasts or simulations but also for calculating the national impacts of regional policies and regional disequilibria. In these models, national figures are often calculated by aggregation of regional variables (Courbis 1982a). This implies that a complete analysis of regional supply and demand, of the regional labor market, and of the regional income distribution is to be introduced at the regional level. That is, regional information must be adapted to the modeling requirements (the opposite may be true for top-down models). Also, regional data should be available for all the regions and be consistent with the national figures. Consequently, one has to have a completely integrated and consistent system of regional and national accounts. If a disaggregation by industry is introduced, it is necessary to have – at least for a base year – a consistent multiregional input–output table (and even a multi- and interregional table if regional production depends on demand in each region).

Thus, it is seen that different approaches to regional and multiregional modeling do not imply the same statistical requirements.

2. Statistical Problems and Analysis of Regional Production

Very often, "economic base" theory forms the background for determining regional production. In this case, effective demand directly determines production and no "supply" effects are introduced.* For nonexporting industries we have consequently to determine regional demand but, in a reduced form, we can link directly regional production (or employment) of nonexporting industries to regional production (or employment) of exporting industries, as regional income and regional demand depend on income and demand created by the exporting industries.

Consequently, in the economic base approach, the main problem is to describe the relationship between the regional production of exporting industries and effective demand inside and outside the region. Two cases are to be considered, according to whether one has a "national" market or a segmented multiregional market.

In the case of a "national" market (as in the Leontief (1953) model), regional production of exporting industries is a share of national total effective demand. If the share of each region is assumed exogenous, it is only required to have a few observations for regional production. But, alternatively, regional shares can also be endogenous (Courbis 1982a) and, for example, be determined as a function of comparative regional costs.

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* See the theoretical formulations proposed by Bell (1967) and by Klein (1969). The Bell model considers explicitly exporting and nonexporting industries, while Klein's formulation corresponds to a reduced form.

One then needs time series for regional production (in a reduced-form approach, one can also consider regional employment as a function of national employment).

For a segmented multiregional market one has to describe interregional flows to determine the total demand related to each region. Data on interregional flows are consequently required, but it is also possible, as with the NRIES model for the US (Ballard and Wendling 1980), to construct a proxy for total demand by weighting effective demand in each region. This proxy (calculated with appropriate weights for each region) is used as an explanatory variable in the econometric determination of production in each region. Such an approach is quite often used for multinational models when one does not explicitly introduce a matrix of trade flows. Its interest is that it only needs time series for production and demand, although having the trade matrix for one year is useful for estimating the weights when aggregating demand by region (or by country). As with the national market, a reduced-form approach in terms of employment could also be used; the statistical requirements are then much weaker.

Data on regional production are required if one wishes to consider explicitly regional production functions, and are certainly necessary if one emphasizes not only demand effects but also supply effects. By placing emphasis only on effective demand, the economic base approach assumes that there is sufficient production capacity in the region(s) considered. If capacity is insufficient, regional production will be determined not by demand but by regional supply. From this point of view, it should be noted that regional investment is usually considered only as a simple component of regional demand: its impact on supply as a factor of production is thus totally neglected. In practice, if regional investments are insufficient there is a progressive limitation of regional production, and bottlenecks appear at the regional level. Because they ignore the impact of regional production capacity on regional production, the economic base model and the demand approach are, in fact, more convenient for short-term analysis. However, for medium-term analysis one has to adopt a supply approach so as to determine the regional production of "footloose" industries (Courbis 1982a).

In the REGINA model for France (Courbis 1975, 1979), the REM1 model for the Netherlands (Van Hamel *et al.* 1975), and the MACEDOINE model for Belgium (Glejser 1975), such a supply approach plays an important role (Courbis (1982b) discusses the determination of regional production). For these models, regional production – at least for some industries* – is determined by (or depends upon) the regional production capacities and regional supply. For the RENA model for Belgium (Thys-Clement *et al.* 1973) regional production capacities are also introduced for determining regional employment, but regional production is demand-determined and

* For some industries (particularly the tertiary industries) regional production is demand-determined. The REGINA model (Courbis 1975, 1979) distinguishes between supply-determined activities and demand-determined activities.

calculated as a share of national total demand.

To introduce such a supply approach for determining production or for considering a regional production function in employment determination, data on the regional stock of capital must be available. For RENA (Belgium), REGINA (France), and REM1 (Netherlands) a chronological approach was adopted, but the methods used for estimating the capital stock for the base year were different: RENA used a breakdown of a national estimate for 1955; REGINA and REM1 used an optimization approach (minimization of the differences between regional production functions for a given national value of capital stock). For MACEDOINE (Belgium) regional capital stock was calculated simultaneously with the estimation of the production function, assuming that the nine Belgian provinces had the same initial capital:output ratio (for 1959).

Improvements in the estimation of regional capital stock would be useful for a better determination of regional production functions and for taking into account the impact of financial limitations on national and regional investments. However, regional data on capital stock are not needed if one adopts a "vintage" approach, as in the Belgian SERENA model (d'Alcantara *et al.* 1980). In all the cases, availability of good data on regional investments is needed, since the connection from regional investments to regional production or employment is one of the most important mechanisms for regional development in the medium term.

While the supply approach emphasizes the impact of regional production capacities and requires that data on regional stocks of capital are available, the demand-oriented approach, on the other hand, needs data on interregional flows (or proxies for total demand) if there is not a perfect national market. The second approach is more convenient for the short term, while the former is more convenient for the medium and long terms. However, such a distinction is too dichotomous and a mixed approach, combining demand and supply effects, would be more realistic. If one wishes to build a dynamic short-term–medium-term model, a mixed approach is necessary. One would, even for "footloose" industries, determine regional production by effective demand (within the region and outside) (Courbis 1982b), but only the introduction of the impact of regional capacities on interregional flows (and on regional foreign trade) would allow reconciliation of the economic base and supply approaches. It is necessary to introduce explicitly the impact of the regional rate of capital utilization on regional external trade (with the other regions and with other countries),* and also on the regional investment location behavior of multiregional firms. In the short term, effective demand would determine regional production, but in the long term, if the rate of capital utilization is considered to be at a "normal level" (with respect to feedbacks on investment), regional production would be determined by regional supply.

* In the multiregional model built for Japan by the Mitsubishi Research Institute (Suzuki *et al.* 1973/1978), interregional flows are explained by the effective demand of importing regions and the capital stock of exporting regions.

Such a mixed, generalized approach needs data on the rate of capital utilization by region. The Belgian RENA model (Thys-Clement *et al.* 1973) includes this rate to explain regional employment. No direct regional data being available, the rate of capital utilization was indirectly estimated by calculating the regional potential output on the basis of a regional production function; the value of regional effective production being known, one could easily calculate the regional rate of capital utilization (the ratio of effective production to potential output). Other methods could be used for calculating the regional rate of capital utilization; for example, the Wharton "peaks method." Further, it appears possible to make direct estimations: in France, experimental work has demonstrated that, at least for large regions, it should be possible to make direct estimations by regionally using the data collected in national surveys of firms, which give information on unemployed production capacities.

If one uses a proxy method for taking into account the impact of effective demand in other regions, as in the NRIES model for the US, statistical information on interregional flows is not required, though such data improve both the determination of regional production in the model and the consistency of regional production and regional demand for the past.* Similarly, one can include a multiregional input–output table in an econometric "integrated regional–national" model, even if such a table is only needed for determining the regional production of demand-oriented industries.** However, constructing multiregional (and interregional) input–output tables requires great statistical effort. It was done for the REGINA model of the French economy (Courbis 1975, 1979) but this is an exception. Indeed, using a multiregional input–output table improves the determination of production and demand, as well as the calculation of intermediate demand (at the regional level). Since important statistical work was carried out for several countries in the 1970s (Courbis (1982c) discusses EEC countries), using such a method is now much easier than ten years ago. However, it would be useful to have not only a table for one year but also time series for regional production according to industry and regional demand according to product.

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* One can calculate the regional external trade surplus (or deficit) in two ways: firstly as the difference between regional production and regional demand; secondly as the balance of interregional flows (and external trade with foreign countries). Such a comparison, which was made when estimating the multi- and interregional input–output tables for France (Courbis and Pommier 1979), helps to improve the quality of regional estimations.

** For supply-oriented industries, regional production is, in the medium term, determined by the regional stock of capital, and equality between production and demand is achieved through regional external trade.

3. Regional Income, Regional Costs, Prices, and Financing

Obviously, good data on regional distribution of income are useful for linking regional household consumption to household disposable income. Generally, one has sufficiently good information on regional wages and salaries, the incomes of the agricultural self-employed, and social transfers, but it is much more difficult to acquire data on the incomes of nonagricultural private businesses. There are also conceptual problems, some data being available for distributed income (or for household expenditure) created in each region whereas other data are only available in terms of households living in one region (at the national level, the differences between "national" and "domestic" approaches are quite similar but consistency is much more easy to achieve).

Information on regional income distribution is not only useful for analyzing regional demand: regional primary incomes are also a component of unit production costs. If we integrate supply effects, regional data on primary incomes and regional unit costs are first needed for estimating the impact of regional unit costs on regional development potential and the location behavior of "footloose" industries.* At the same time, one can calculate national average unit costs by aggregation of regional unit costs, allowing the introduction of regional feedback on national costs and national profitability. The simulations made for the French economy with REGINA have demonstrated the importance of this feedback on national development (national growth, employment, inflation, external trade balance, etc.). Therefore, it is important to have regional data on unit costs and thus on the regional distribution of income (by industry if possible).

As labor unit cost is the most important component of total unit cost, good information on regional wage rates is needed. Time series for regional wages are required so that an econometric analysis of the dynamics of increase in nominal wages is possible at the regional level. Since there is no perfect national labor market and since there are regionally segmented labor markets, the regional increase of wages depends on regional conditions. Owing to the nonlinearity of the relationship between unemployment and the increase in wages, the national average wage increase depends not only on the national rate of unemployment (and inflation) but also on the degree of dispersion of regional rates of unemployment. This introduces an important feedback of regional labor market disequilibria on the national average wage increase. It is also important to notice that regional wage determination may not be a homogeneous process. Wage increases in one region can often have diffusion effects in others. Such a mechanism reinforces the impact that the determination of regional wages has on national development (Courbis 1982a). From a

* Regional data on distributed income and costs are also needed for analyzing the profitability of monoregional firms and for estimating the impact of financing possibilities on the investments of such firms.

statistical point of view, it would be necessary to have time series for regional wages so that the regional increase could be econometrically analyzed; to describe the diffusion process a great number of observations are required for a simultaneous estimation.

At the national level, national unit costs – and consequently regional unit costs – are one of the main determinants of price increases. For commodities produced by "footloose" industries, in the absence of a perfect and totally competitive national market, it is possible to assume a hierarchy of regional prices. Under these conditions, for the long and medium terms one need only consider the national average increase in prices (which is assumed to be the same for all regions). In making such an assumption, no data are required on regional prices. Such a simplification is more difficult for "located" industries. For these, modeling the price increase at the regional level would be necessary but, unfortunately, statistical data on regional prices are often difficult to obtain. Improvements in this field would be helpful.

One other statistical problem is related to financial data. In a supply approach, which emphasizes the impact of financing on investments, data on regional credit and regional financing would be useful. If there is a polarization of the financial system, savings in one region might not necessarily be disposable for that region and hence there is a transfer of financial resources among regions. It appears also that financial behavior can differ from one region to another (not only for households but also for monoregional firms). For all these reasons, improving regional information on financial and monetary flows would be useful for integrating the analysis of the impacts of money and financing in a multiregional model. For France, a first statistical attempt was made with the regional financial accounts built by Rochoux (1979) in the Group for Applied Macroeconomic Analysis in Nanterre.

Improvements in multiregional modeling must be based on statistical improvements. However, it is also true that work on multiregional models brings to light which statistical data are required and which statistical improvements have to be made.

References

d'Alcantara, G., J. Floridor, and E. Pollefliet (1980) Major features of the SERENA model for the Belgian Plan. *Working Paper* 2279, Bureau of Planning, Brussels.

Ballard, K.P., and R.M. Wendling (1980) The national–regional impact evaluation system: A spatial model of US economic and demographic activity. *Journal of Regional Science* 20(2):143–158.

Bell, F.W. (1967) An econometric forecasting model for a region. *Journal of Regional Science* 7(2):109–127.

Courbis, R. (1975) Le modèle REGINA, modèle du développement national, régional et urbain de l'économie française. *Economie Appliquée* 28(2–3):569–600.

Courbis, R. (1979) The REGINA model, a regional–national model for French planning. *Regional Science and Urban Economics* 9(2–3):117–139.

Courbis, R. (1982a) Multiregional modeling: A general appraisal. *Regional Development Modeling: Theory and Practice*, eds. M. Albegov *et al.* (Amsterdam: North-Holland), pp. 65–84.

Courbis, R. (1982b) Integrated multiregional modeling in Western Europe. *Multiregional Economic Modeling: Practice and Prospect*, eds. B. Issaev *et al.* (Amsterdam: North-Holland), pp. 111–127.

Courbis, R. (1982c) La construction de tableaux d'entrées–sorties multirégionaux. *Paper* presented at Seminar on Regional Accounting in EEC Countries (Luxemburg: Statistical Office of European Communities).

Courbis, R., and C. Pommier (1979) *Construction d'un Tableau d'Echanges Inter-Industriels et Inter-Régionaux de l'Economie Française* (Paris: Economica).

Glejser, H. (1975) MACEDOINE, un modèle régional de l'économie belge. *Working Paper*, Bureau of Planning, Brussels.

Issaev, B., P. Nijkamp, P. Rietveld, and F. Snickars (eds.) (1982) *Multiregional Economic Modeling: Practice and Prospect* (Amsterdam: North-Holland).

Klein, L.R. (1969) The specification of regional econometric models. *Papers of the Regional Science Association* 23:105–115.

Leontief, W. (1953) Interregional theory. *Studies in the Structure of the American Economy*, eds. W. Leontief *et al.* (New York, NY: Oxford University Press), pp. 93–115.

Polenske, K.R. (1980) *The US Multiregional Input–Output Accounts and Model* (Lexington, MA: Lexington Books).

Rochoux, J.Y. (1979) Analyse régionale des opérations financières. *Doctorate Dissertation*, GAMA, University of Paris – Nanterre.

Suzuki, N., F. Kimura, and Y. Yoshida (1973/1978) Regional dispersion policies and their effects on industries – Calculations based on an interregional input–output model. *Working Papers*, Mitsubishi Research Institute, Tokyo.

Thys-Clement, F., P. Van Rompuy, and L. de Corel (1973) RENA, *un Modèle Econométrique pour l'Elaboration du Plan 1976–1980* (Brussels: Bureau of Planning).

Van Hamel, B.A., H. Hetsen, and J.H.M. Kok (1975) Un modèle économique multirégional pour les Pays-Bas. *Utilisation des Systèmes de Modèles dans la Planification* (Geneva: UN Economic Commission for Europe), pp. 212–267.

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CHAPTER 12

Models as Integral Parts of Regional Information Systems: Experiences from Italy and Sweden

Giuliano Bianchi, Börje Johansson, and **Folke Snickars**

1. The Demand for Information in Regional Planning

Regional planning has different connotations and traditions in different countries, and the intensity of regional planning efforts varies considerably between them. Its role in the political arena depends on how political power is distributed among decision-making bodies at various geographic levels in a nation. Regional planning may be exercised mainly by the central government and its planning agencies, or by local and regional decision-making organizations. This chapter focuses on information as an input to the planning activity and policy analysis of regional authorities. It does so from the perspective of open economic regions that are vulnerable to external influences. In particular, the chapter describes experiences gained in the design of an information and forecasting system for the Tuscany region in Italy. Also, comparisons are made between Italian and Swedish experiences.

1.1. *Changing Conditions for Regional Planning*

In many industrialized nations the trend during recent decades has been a gradual replacement of local economic linkages by international ones. At the same time technical change has been labor-saving in the industrial sectors, while services have remained labor-intensive. Also, industry has increased its demand for technical and business services. As a consequence, in the postindustrial society a larger share of the employed population has become dependent on local and regional production.

Simultaneously, existing ties to industrial sectors imply prevailing indirect influences of world market changes on the local economy.

Specialization and associated economies of scale have also led to an increased vulnerability of the local economy. In a global situation of technological transition, the developments mentioned above have increased the demand of local and regional authorities for information, and the scope of regional planning has increased.

1.2. *Absence of a Theoretical Foundation*

Comparing Italy and Sweden, one may conclude that the trends already described are shared by these two nations. The similarity is strong in spite of important national differences in the organization of local and regional planning. Other observations suggest that these trends are occurring throughout a major part of the industrialized world. As a result, regional authorities in many countries are experiencing increasing incompatibility between planning requirements and existing information systems.

Local and regional planning has traditionally had a weak analytic background. Practical relevance in a narrow sense has been used as a guideline at the expense of comprehensiveness and consistency. This may be due to the following fundamental characteristics of regional planning and policy analysis as they are practised:

- Planning strategies do not stem from analysis but rather from preconceptions.
- Policy generation does not rest on formal evaluation of alternative courses of action but rather on qualitative judgments.
- Policy implementation is not assessed by means of efficient monitoring procedures.

Bianchi (1981) has identified prevailing political tradition in Italy as a fundamental reason for inefficient use of information in public planning at the regional level. Quantitative analysis has not been able to break that tradition so far. This predicament, which has been phrased as a "divorce between knowledge and government," is largely independent of the planning philosophy adopted.

Information processing by means of modern information technology is equally relevant for all planning concepts ranging over the rational, incremental, adaptive, and pure monitoring paradigms (Wilson 1980). However, the functions of models and the types of information generated by information systems will depend on the particular planning concept adopted.

2. Organization of Information Supply

The local and regional demand for information can vary, with respect to information content, over regions and over time within a region. This raises the question whether information collection and production should be regionalized or centralized.

2.1. *Central, Overall Perspectives*

In most countries today, decentralized, heterogeneous demands for information from the regional planning levels are basically met by a centralized, homogeneous supply. One should also note that the central government and related authorities also have a demand for regional information. From their point of view, regional homogeneity is a desirable property.

In Italy most regional data are provided by ISTAT (Italian National Institute of Statistics). In Sweden the SCB (Central Bureau of Statistics) has a strong position in offering the municipalities regular data for planning. Designed some fifty years ago, ISTAT still operates in the same way, in principle, as the SCB. There is a flow of questionnaires and instructions from the center to the periphery; the opposite flow mainly consists of collected data. Decisions about production, processing, and publication of data are made at the central level, due notice being made of the quality and relevance of the data at that level.

In Italy the feedback of information to the regional level (regional and local governments, local authorities, etc.) is meager. Currently, ISTAT annually handles about 180 surveys and more than 450 questionnaires. Thus a huge gathering of data (which are regionally specified in their original form) results in several thousands of published pages. Few of them report municipal data. Moreover, only in some cases are local respondents, like authorities, allowed to keep the data they collect. Although ISTAT has recently been exhibiting a more liberal attitude, as far as access to basic data from local authorities is concerned, there is still a clear contradiction between the old, centrally oriented statistical system in the country and its more recent, decentralized government system, in which the number of decision centers has multiplied.

2.2. *Options for Decentralization*

As shown by Guteland and Nygren in Chapter 19 of this book, the centralized statistical bureau in Sweden also has a monopoly on information. However, in this case there is a significant feedback, although this information flow is not designed to reflect the specific demands each regional decision-making body may have.

While new planning ambitions have altered the pattern of demand for regional information, new communication technologies have transformed the conditions of processing and retrieving information. Each region may, in principle, look for an individually designed solution, since technically it is now possible to effect a complete decentralization of statistical information systems. This does not imply that the responsibility for collecting microscale data should be transferred to regional agencies. However, there is a need to examine carefully various options.

The ability of regional authorities and statistical offices to operate and utilize advanced information systems varies considerably between different regions and municipalities, both in Italy and in Sweden. The development of systems for providing supporting information for comprehensive regional planning has been weak and fragmentary in both countries. From this perspective, the information system created for the Tuscany region breaks new ground.

3. Purposes of Regional Information Systems

The tensions between existing information systems and regional decision-making requirements are complicated. They relate both to the roles and objectives of analyses and methods for policy evaluation, and to the shortcomings of the official statistics service (reliability, updating, coverage, disaggregation, etc.). Therefore, the tensions cannot be removed by a single measure. We shall illustrate this problem from the viewpoint of a regional planning and information-processing body that provides background information and analysis in the form of decision support for comprehensive regional economic planning.

3.1. *Interdependences Between Information and Planning Systems*

Statistical, information, and planning systems are coupled. For example, changes made in the second will have impacts on the third. Therefore, modification of the planning system cannot be considered independently of the initial information system.

The primary aim of information systems in regional planning has traditionally been to store data for multipurpose use in large computer systems. The data aspect has been stressed at the expense of planning relevance. This is the case in both Italy and Sweden, and the observation can probably be generally applied to other industrialized countries. Huge resources have been allocated to setting up, maintaining, and updating data bases. Considerable resources have also been allotted to developing streamlined tools for extracting arbitrary combinations of data in numerical or graphic form. These developments are partly explained by a persistent lack of contact between designers of information systems and planners using the information.

Table 1 illustrates observed or potential shifts in demand for information and decision support on the local and regional levels. These shifts are in contrast to the historical situation described above.

Table 1 Emerging trends in the design of information systems.

From:	To:
Large multipurpose data bases	Selected strategic data
Administrative data	Policy-oriented information
Relevant statistics of the most frequent events	Pertinent information for causal analysis (and understanding)
Quantitative data in tabular form	Interpreted information and qualitative signals

3.2. *Planning-Oriented Information Processing and Strategic Applications*

The main criticism of data-processing support given to local and regional governments during recent decades is that tactical rather than strategic applications have been given priority. Computer systems have been used for mass storage and bookkeeping rather than as active tools in the decision-making process.

Table 1 illustrates a transition to a situation in which computer technology has increased the potential for underpinning plan making with analysis. Does this have any implications for the future balance between market solutions and planning efforts? Market solutions need little centralized information but give rise to external effects that have to be coped with by the public sector. This presupposes more efficient monitoring. Planning, on the other hand, needs more information to become efficient but may, with proper decision support, increase the possibility of internalizing the external effects in the plan-making process. Better information systems should increase the scope and pertinence of planning.

Improvements in the regional planning process may be achieved by addressing at least three control issues:

- The organization of useful data through selection from a variety of data bases needs to be ameliorated.
- Tools for generating information from these special-purpose data bases must be constructed in such a way that they fit into the planning process. Models for combined forecasting and scenario analysis may be of special interest.
- Networks and other structures for dissemination of information must be constructed in order to speed up the technical phases of the planning process. This represents an integration of information processing and the planning process.

4. Regional Information and Planning System Models

We shall now give an example of a possible way of organizing a combined information and planning system for a regional economy. Thus, in this context we do not refer to a planning system in general terms but to a specific combination of the two components. The example involves a collaborative effort between the Regional Institute for Economic Planning of Tuscany (IRPET) in Italy and the Integrated Regional and Urban Development Group of the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria. The complete information system is described by Bianchi and Baglioni (1982) while the core of the planning system, in the form of a set of regional economic models, is described by Cavalieri *et al.* (1983).

4.1. *Specifying the System: Three Categories of Models*

In the considerations that led to the regional information system for the economic planning of Tuscany three major variants for the framework of the system were distinguished: the logical model, the functional model, and the information model.

The ***logical model*** identifies the logical components or phases of planning in terms of operational steps in the plan-making process as well as in terms of the content of the plan as a written document. This model provides guidelines for plan preparation. The weakest links of the process involve the introduction of tools for effectively recording the state of the region, for generating policies, and for monitoring the consequences of policies.

The ***functional model*** describes interactions among various agents of the regional and local planning systems (regional government, regional agencies, local authorities, and sectoral bodies). During plan making and decision making those interactions take the form of (i) commands from the regional government to its departments, (ii) joint decisions between regional and local authorities, (iii) agreements between the regional government and higher levels of government, such as the state or the EEC, and (iv) bargaining between regional bodies and sectoral bodies, such as trade unions. Implementation may be direct, i.e. by regional departments or agencies, or indirect, by delegation of tasks to local authorities or other agencies. In those cases information can be regarded as the only material circulating through the network of the planning system. The emphasis is on the two-way flow connecting center and periphery. The bottom-up flow of data referring to processes and plan accomplishments is complemented by a top-down feedback of information in the form of forecasts, indicators, reports, and comparisons.

The ***information model*** does not relate to any specific decision-making unit or agency. The information function is diffused through the regional government departments and through agencies and offices of local authorities. There is, however, a special role to be played by the departments for statistics and information at the regional level as well as by the research institute or department in charge of overall regional planning. Figure 1 shows a configuration of the information model.

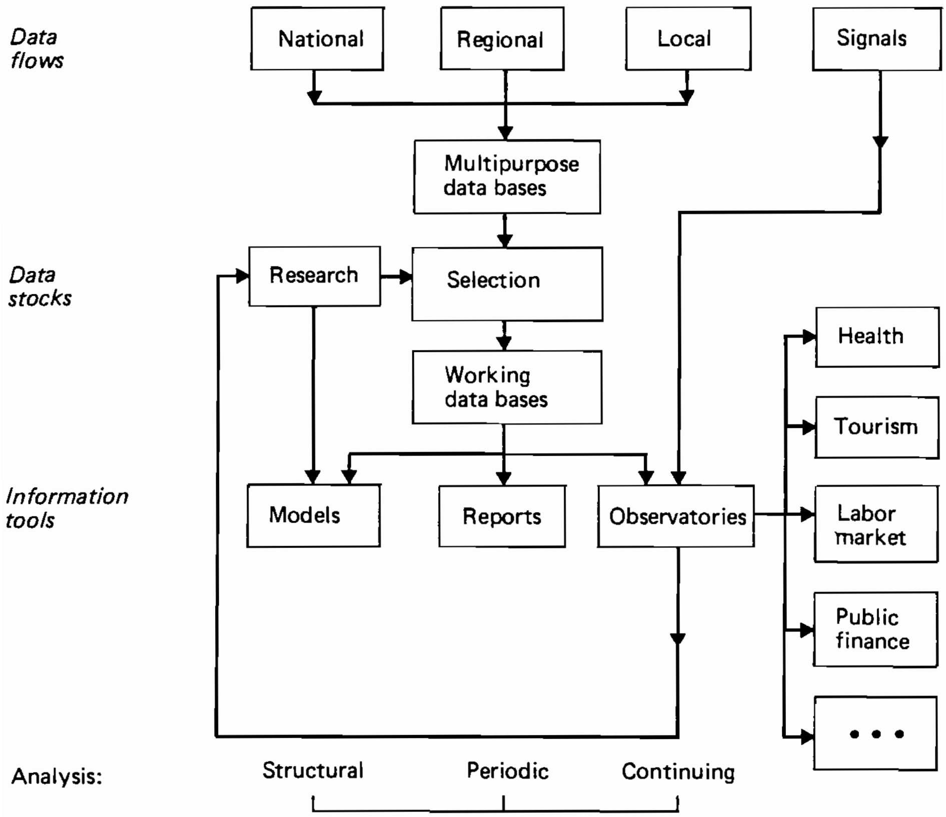

Figure 1 Outline of the IRPET information system applied in Tuscany.

4.2. *System Design and Information Tools*

The setup of the information system illustrated in Figure 1 may be explained by reference to data flows, data stocks, and information tools.

Data flows, stemming from statistical surveys and administrative records, feed and update multipurpose data bases. The latter constitute a data pool contributed to by regional and local authorities and other public and private institutions, as well as by national statistical agencies. According to a set of criteria, data can be selected from multipurpose data bases and organized in working data bases. These data bases, together with data collected through specific surveys and field research, form ***data stocks***, to be updated for retrieval and for further processing by means of ***information tools***. These tools transform data into information that is useful for planners. They are used for analyzing data and produce various kinds of information, such as

- a "continuous" flow of information through "observatories" (or monitoring stations);
- periodic information in the form of reports; and
- structural information from models supporting forecasting and impact analysis.

Observatories are the key components of the system. They rely upon small working teams in charge of organizing and maintaining sectoral data flows and files. They produce sets of indicators very frequently (sectoral trends and policy performance); they also stimulate novel research when indicators show anomalous or surprising values compared with expected performance levels. Therefore, these observatories are an essential means of monitoring planning activities and results.

Reports normally contain analyses of trends of regional development in order to give annually a comprehensive view of the regional system; the reports also assess policy implementation and achievements. In this way, they contribute to monitoring functions. They consequently exert a positive impulse to the improvement of the information system as a whole, since they require the reporting group to mobilize every possible information resource.

Models represent the very core of the information system, and they are organized as a flexible linked system. That is, they are not formed into a rigid "supermodel" but, instead, are constructed as individual modules that can be connected with each other in various ways. The models can help in extending current trends and cycles into forecasts for different time horizons. Hence, historical, current, and projected information are looked upon in the same way within the information system. Of course, the models produce results that are used for the reports and observatories. Signals about new developments may therefore originate both from working data bases and from model exercises. Over time, modules and their linkages may be renewed, and signals from the monitoring system may prompt the reorganization and refinement of some set of these submodels.

5. Outline of the Regional Model System

The core model of the Tuscany information system relies on the availability of recent regional input–output tables. These tables are derived by direct survey methods, and this makes the input–output information more interesting than when direct data are not available. In contrast, the associated capital coefficient matrix (describing investment inputs and capacity outputs) has been derived only from national data (Westin *et al.* 1982).

In fact, the model system has a biregional input–output component as its core. The regions are Tuscany and the rest of Italy; information about the latter has been obtained by combining data about the Tuscan economy and the national economy. The model system is also complemented by a national econometric model.

5.1. *Overview of the Model System*

The traits of the system of linked models may be summarized as follows.

- It is a biased two-region system in the sense that, although both Tuscany and the rest of Italy are represented by complete economic models, the economy of Tuscany is modeled in more detail.
- The system contains a stronger emphasis on international trade than similar multiregional economic models.
- The public sector plays a more pertinent role than is found in the mainstream of this type of modeling. The public sector is represented both as a provider of public goods and services (including income transfers), and as a supplier of public infrastructure.

Figure 2 illustrates the seven modules of the model system. To these must be added at least two further components that represent interregional trade links and regional–national–international links. These interregional and international relationships are of special importance to the Tuscany region in view of its openness and the significance of exports. The international aspect is concerned not only with exports of goods such as leather and textile products, but also with international tourism in the region.

The core model of the system is the biregional input–output model, TIM, which provides, for both Tuscany and the rest of Italy, matrices of intermediate consumption and of (interregional and international) trade coefficients.

The export model, MEXT, is an export demand model, with a destination (importing country) as well as a commodity specification. This means that economic developments in the importing countries will have a direct influence on the economic performance of Tuscany. A certain degree of substitution between interregional and international exports is also possible.

The importance of the capacity concept for a regional economy has led to the indirect modeling of capacity creation (INVEST). This model operates on an annual basis. It is complemented by a five-year variant, which treats investments and capacity creation. The investments are transformed into exogenous annual inputs, yielding capacity limits that cannot be exceeded. Short-term bottlenecks or supply–demand tensions will then have to be resolved by interregional, or even international, trade adjustments.

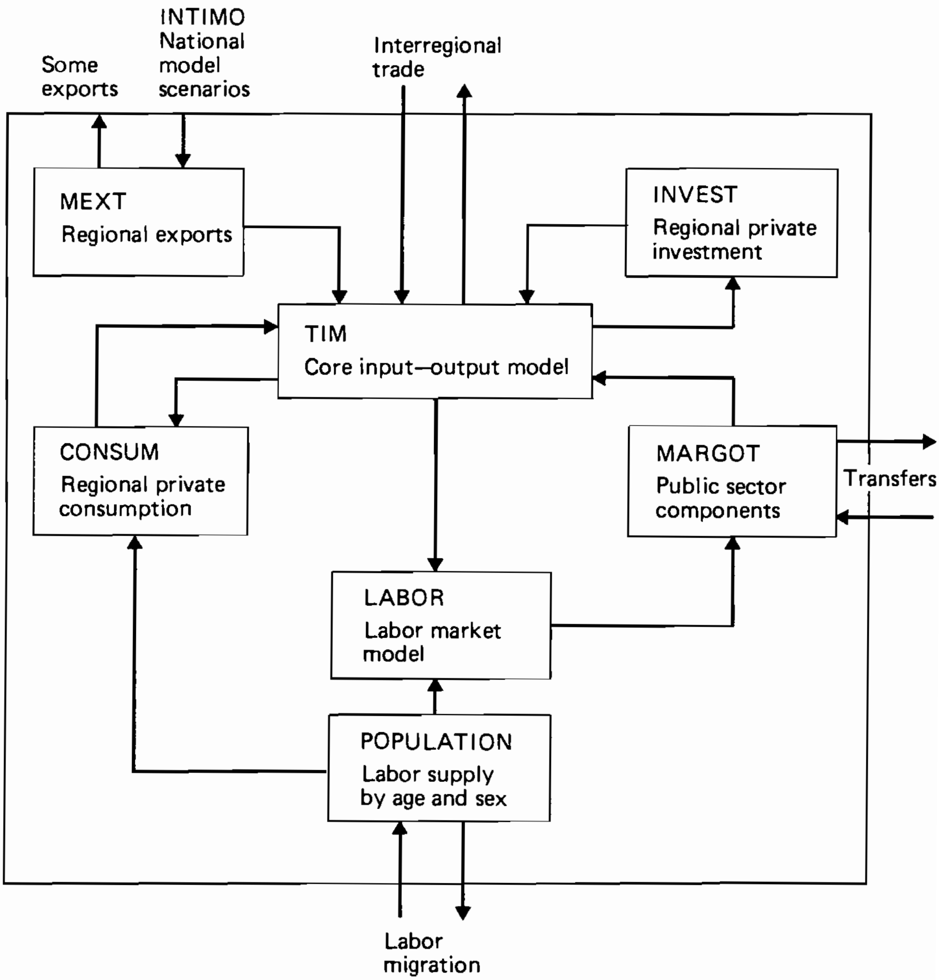

Figure 2 The regional part of the model system for regional planning in Tuscany.

The labor market model, LABOR, is not only tied to the production system through the labor input process. It also interacts with the population module through labor force participation and unemployment. These variables are determined by a simple form of labor market model that acts as a balancing mechanism between labor supply and demand.

The public sector model, MARGOT, and the private consumption component, CONSUM, are closely related because the disposable income policies affect the patterns of final demand both directly and indirectly. The private consumption model is based on the concepts proposed for the INFORUM system (Almon 1981), and has already been applied in the INTIMO model for Italy (Grassini 1982).

5.2. *Existing Features and Future Options*

The model system is primarily intended for medium-term forecasting, policy evaluation, and planning. This is true, at least, for the version conceived and currently operated. In particular, it does not address long-term problems of technological change.

The model system described here is intended to be a tool for consistent economic forecasting with regard to the regional economy of Tuscany. In the scenarios attained with solutions of the system, there is a consistency (i) between total demand and production capacity, (ii) between production and deliveries to consumption and investment, and (iii) between regional location of production capacity and the structure of regional trade.

The model system is also used for policy evaluation, and for monitoring structural change as well as imbalances in the Tuscan economy. In this fashion it may serve several purposes in the context of the larger information system. When used as a policy evaluation tool, forecasts are made conditional on policy actions being exogenously inserted into the model system. The system could also be applied as a planning tool by introducing mechanisms for the selection of policy instruments/decisions that satisfy given performance criteria. The usefulness of this option depends on the room for such design deliberations in the actual planning process. Experience from other kinds of policy-applied modeling shows that such demands evolve as a natural stage in the development process. A modular design will prepare for such options.

6. Conclusions about Models and Information Processing

Our main conclusion with regard to the long-term viability of information systems for regional planning is that they need to be supplied with analytic capabilities. These should be developed to comprise forecasting, policy assessment, and planning models. Without such facilities, information systems will lose contact with planning after an initial phase of enthusiasm during development. On the other hand, regional economic models, statistical inference models, and other policy-relevant models need to be linked more closely to special-purpose information systems, otherwise their connection with planning will disappear soon after the construction phase. The latter brings about the necessary interaction between researchers and planners. However, this interaction will not continue without devices to ensure that further development is stimulated. Experiments such as the one described in this chapter indicate a viable way to proceed in this respect.

References

Almon, C. (1981) An international family of linked input–output models. *Paper* presented at International Conference on Structural Economic Analysis and Planning in Time and Space, University of Umeå, Umeå, Sweden, June.

Bianchi, G. (1981) Informazione economico-sociale, governo regionale e locale, informazione statistica. *Atti del Convegno SIS*, vol.I.

Bianchi, G., and P. Baglioni (1982) Regional information and planning systems. *Paper* presented at Workshop on Information Systems for Integrated Regional Development, International Institute for Applied Systems Analysis, Laxenburg, Austria, 15–17 December.

Cavalieri, A., D. Martellato, and F. Snickars (1983) A model system for policy impact analysis in the Tuscany region. *Papers of the Regional Science Association* (forthcoming).

Grassini, M. (1982) A national scenario for a regional model. *Working Paper* WP-82-131, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Westin, L., B. Johansson, and M. Grassini (1982) Estimation of capital matrices for multisectoral models: An application to Italy and Tuscany. *Working Paper* WP-82-92, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Wilson, D.E. (1980) *The National Planning Idea in US Public Policy: Five Alternative Approaches* (Boulder, CO: Westview).

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CHAPTER 13

Information Content of Data from Different Spatial Aggregation Levels

Peter Nijkamp, Piet Rietveld, and **Annemarie Rima**

1. Introduction

An information system (the monitoring system, computer graphics system, regional model, etc.) contains a set of organized data for improving the quality of decision making. Structuring the data involves a transformation of the original data into categories encompassing general patterns and trends. If the original data are regarded as numerical attributes of a certain phenomenon, one may use $x_{i,r,t}$ to represent a numerical value (on a certain measurement scale) assigned to phenomenon i in region r in period t. We will confine ourselves to the spatial aspects of this symbol, in regard to which some important questions emerge: Is there an appropriate way of consistently *aggregating* spatial microdata into macrodata? How are model results affected by the choice of *spatial scale*? These questions will be dealt with in this chapter, with special emphasis on model results emerging from different spatial scales (Baumann *et al.* 1983).

Prior to any statistical and econometric regional analysis, a basic decision to be made when designing regional information systems is the choice of the appropriate level of spatial detail. The two main influences on this choice are the cost of collecting data and the usefulness of the information that can be derived from the data. These influences are in general conflicting. The costs involved at the level of small basic areal units are usually extremely high. Also, rules of confidentiality may give rise to sociopolitical problems with such units. On the other hand, the number of purposes for which information systems could be used may increase considerably if detailed spatial information could be produced.

Obviously, it is fairly impossible to design simple rules for specifying the range of spatial detail within which a best compromise between these conflicting viewpoints has to be found. In this chapter a more modest aim will be pursued. One particular aspect of the choice problem will be dealt with: the extent to which the choice of a certain level of spatial detail affects the quality of the information that can be produced for analysis and forecasting.

Research in this field has given rise to remarkable results (e.g. Alker 1969, Hordijk 1979, Openshaw and Taylor 1981, Lohmoeller *et al.* 1983). It appears that statistical associations for aggregated populations may differ in magnitude and even in sign from those for individual members of a population. The well known ecological fallacy arises when correlations observed between variables at an aggregate level are used as substitutes for individual correlations. Clearly, when data are only available at a high level of spatial aggregation, it is impossible to test the sensitivity of statistical associations for lower levels of aggregation.

The chapter has been organized as follows. Section 2 deals with different types of aggregation relevant to spatial information systems. In Section 3, the use of disaggregate as distinct from aggregate data is discussed in the context of (multi)regional models. Section 4 is devoted to an empirical illustration in the field of regional labor markets, in which three spatial levels have been distinguished.

2. Types of Aggregation

Aggregation may be carried out in various ways: across individuals, economic sectors, spatial units, time, etc. This condensation of information inevitably entails loss of detail (e.g. Orcutt *et al.* 1968) but, if properly carried out, it may improve the understanding of phenomena by focusing on important general features of the data. Data as such are an insufficient basis, however, for determining the relevance and importance of a feature: the purposes for which the information is needed must also be considered, so that, preferably, aggregation procedures should be adapted to these purposes.

2.1. *Aggregation of Spatial Units*

In many countries regional information systems are based on a generally accepted hierarchy of regions: municipality, county, province (state), and nation. For the majority of purposes, users confine themselves to this regionalization, which means that they usually express their information needs in terms of the desired average size of regions, but not in terms of the composition of regions.

The composition of regions may be based on entirely different principles (e.g. Harvey 1969). One way of forming them is to keep to existing administrative regions. Another way is to construct regions on the basis of a homogeneity principle, in order to achieve intraregional similarity according to economic structure, type of landscape, degree of urbanization, etc. A third way is to use the functionality principle, whereby the composition of a region is determined on the basis of the intensity of spatial linkages.

A regionalization principle does not completely determine the composition of regions. Each principle has to be supplemented with a clustering method before a regionalization can be achieved. As shown by Fischer (1982), there are many clustering methods that will, in general, give rise to different aggregations of basic areal units.

2.2. *Aggregation of Relationships*

As long as descriptive purposes are dominant in the use of information systems, aggregation of (spatial) units will not give rise to many problems. When analytic and forecasting purposes come into play, however, this no longer holds true. Then the question arises how relationships between variables are affected by aggregation of individual units (Akdeniz and Milliken 1975, van Daal 1980).

In our presentation of the problems involved in aggregating relationships we will follow Theil (1954). Let us consider I individual units (e.g. households or basic areal units) and suppose that for each unit i the variable y_i depends linearly on the predetermined variables $x_{ki} (k = 1,\dots,K)$. Thus one arrives at the following microrelations:

$$y_{it} = \alpha_i + \sum_{k=1}^{K} \beta_{ki} x_{kit} + u_{it} \quad (t = 1,\dots,T), \tag{1}$$

where α_i and β_{ki} are microparameters and u_{it} is a disturbance term, being independent of x_{kit} $(\forall k,i,t)$ and having a mean of zero. Macrovariables can be defined as follows:

$$y_t = \sum_{i=1}^{I} y_{it} \ , \ x_{kt} = \sum_{i=1}^{I} x_{kit} \ (k = 1,\dots,K,\ t = 1,\dots,T) \tag{2}$$

(or as weighted averages of the microvariables).

Aggregation of relationship (1) across individuals gives

$$y_t = \sum_{i=1}^{I} \alpha_i + \sum_{i=1}^{I}\sum_{k=1}^{K} \beta_{ki} x_{kit} + \sum_{i=1}^{I} u_{it} \quad (t = 1,\dots,T) . \tag{3}$$

This expression is in general not identical to the macrorelation obtained by interpreting (1) in terms of macrovariables:

$$y_t = \alpha + \sum_{k=1}^{K} \beta_k x_{kt} + u_t \ (t = 1,\dots,T), \tag{4}$$

in which α and β_k are the macroparameters and u_t are disturbance terms with means of zero.

In this case of a simple linear model a necessary and sufficient condition for complete correspondence between (3) and (4) is (assuming that no restrictions are imposed on the distribution of the predetermined variables):

$$\beta_{ki} = \beta_{kj} \ \forall i,j \ . \tag{5}$$

When condition (5) holds, we speak of perfect aggregation. When condition (5) does not hold, while the macrorelation (4) is still used (because of the absence of data at the individual level) one commits a specification error, which may give rise to misleading results.

Condition (5) can be relaxed when certain restrictions are imposed on the distribution of the predetermined variables. These restrictions can be formulated by means of so-called auxiliary equations. More details can be found in Theil (1954).

3. The Relevance of Perfect Aggregation

In the previous section we concluded that only in rather exceptional cases is an analysis at a high level of (spatial) aggregation in agreement with behavioral relationships specified at the microlevel. Therefore, one might expect an emphasis in research on analysis at low levels of spatial aggregation. The reality is different, however: it appears that aggregate data are frequently used and often with reasonable results. There are several possible explanations:

(1) Macrodata are usually more reliable than data at more disaggregated levels, because measurement errors may level each other out, for instance. Also, the length of the time series available for the former is often longer than for the microdata.

(2) The coefficients of the independent variables do not differ significantly at the disaggregate level. Then the condition of perfect aggregation is approximately satisfied.

(3) The point of departure from the theory of perfect aggregation is the microrelation (1). If this equation is improperly specified, the notion of perfect aggregation loses its value, for example, when the microrelations are nonlinear (Kelejian 1980). More importantly, Grunfeld and Griliches (1960) and Green (1977) point to the fact that in equation (1) only variables of one particular level play a role. Thus, it assumes that behavior at the disaggregate level is not influenced by variables at the aggregate level. Grunfeld and Griliches present results of forecasts of investments according to which the macro approach (4)

performs better than the disaggregate approach (3). Hence, they conclude that aggregation is not necessarily bad.

This last explanation, which is the most fundamental, immediately ties in with arguments concerning top-down and bottom-up approaches in regional modeling. Therefore, we will now pay attention to the meaning of these approaches.

The following classification of multiregional models, illustrated in Figure 1, is fairly common (e.g. Courbis 1982, Nijkamp and Rietveld 1982):

(1) Top-down models
(2) Bottom-up models
(3) Interregional models
(4) Regional–national models.

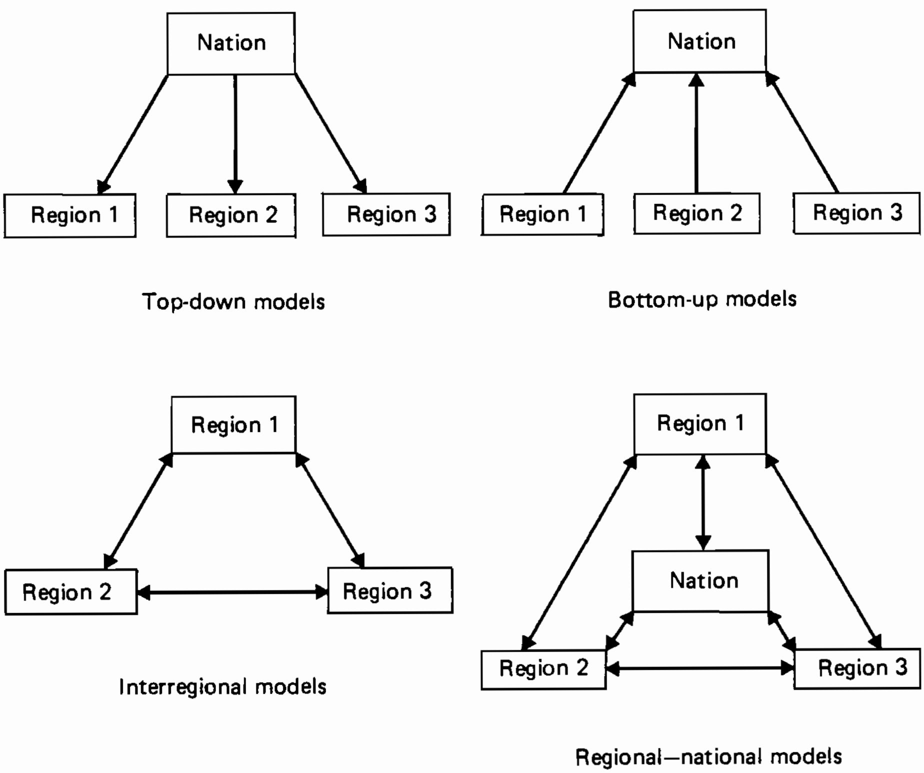

Figure 1 Structures of multiregional models.

(1) *Top-down models*

In top-down models, the values of the national variables are assumed to be known. The values of the corresponding regional variables can be deduced from the national variables by means of a disaggregation method. An advantage of this way of model building is that a multiregional model with a top-down structure can be linked immediately with existing national economic models. One of the disadvantages of top-down models is the absence of feedback effects of regional development on national variables.

(2) *Bottom-up models*

In these models, first the variables on the regional level are determined: the corresponding national variables follow by aggregation. A disadvantage of bottom-up models is that they are often based on low-quality data. The availability and reliability of regional data leave much to be desired compared with national data. An advantage of bottom-up models is that they can be used for investigating the possible conflict between national growth and interregional (in)equality.

(3) *Interregional models*

In these models, the relationships between regions receive particular attention (usually by means of input–output models). They are especially useful when the understanding of interregional relationships is the main interest and when no restrictions on these relationships are imposed because of national conditions.

(4) *Regional–national models*

In this type of model, the top-down approach and the bottom-up approach are combined within an interregional modeling framework. The advantage of this union is that there is feedback from the national to the regional level and from the regional variables to the national variables. The values of the national and regional variables are determined simultaneously. A disadvantage of this type of model is its complex structure.

According to this typology, in Section 2 essentially a bottom-up approach is employed. Interregional linkages and linkages from the national level to the regional level are ruled out by the specification of (1). Both types of linkages are important in spatial analysis, however. A top-down approach is appropriate for variables related to institutions (markets, governments, firms) that operate at the national level. A bottom-up approach is appropriate only for variables that refer to institutions operating at low levels of spatial aggregation.

4. A Numerical Example: The Regional Distribution of Disability Allowances

We will now give an empirical example of the effects of spatial aggregation by examining how changes in spatial scale affect the determinants of the number of persons receiving disability allowances in the Netherlands. In this analysis we will not deal with alternative compositions of regions of the same scale; only the scale of regions will be varied. In addition, we will only deal with bottom-up approaches.

We have selected a topic for which a bottom-up approach seems to be reasonable. It is closely related to the labor market, which typically operates at the regional level. We will focus on the number of people receiving disability allowances after having withdrawn from the labor market. The data used can be found in GMD (1977–81) and CBS (1977–81a,b). Substantial regional differences do exist in the shares of people receiving disability payments. It is interesting to explore the extent to which these differences can be explained by economic indicators such as the unemployment rate. If such an explanation could be proven, an implication would be that hidden unemployment exists among the recipients of disability payments. This would be an important implication, since in the Netherlands (until recently) the number of unemployed has been much smaller than the number of recipients of such payments. For example, in 1978, the number of unemployed was approximately 200,000 while the number of recipients of disability allowances amounted to approximately 550,000 (van den Bosch and Petersen 1982).

For the explanation of the number of disability allowance (DB) recipients, the following stock–flow approach will be used. The number at the end of year t (DB_t) is by definition equal to the corresponding number one year before plus the inflow during the year minus the outflow:

$$\mathrm{DB}_t = \mathrm{DB}_{t-1} + \mathrm{DBI}_t - \mathrm{DBO}_t . \tag{6}$$

The number of people leaving the labor market and entering the stock of disability payment recipients, DBI_t, depends on the volume of employment at the end of the preceding period, E_{t-1}. We assume that yearly a certain proportion of employed persons starts receiving payments; this proportion depends on the unemployment rate u_t. Therefore,

$$\mathrm{DBI}_t = \left[\beta_2 + \beta_3\left(\frac{u_{t-1}}{1-u_{t-1}}\right)\right]E_{t-1} \tag{7}$$

or

$$\mathrm{DBI}_t = \beta_2 E_{t-1} + \beta_3 U_{t-1}, \tag{8}$$

where U_{t-1} denotes the number of unemployed at the end of year $t-1$.

For the number of people leaving the stock of disability allowance recipients, we simply assume that yearly a constant fraction leaves:

$$\mathrm{DBO}_t = \gamma \mathrm{DB}_{t-1}. \tag{9}$$

Thus, after substituting (8) and (9) into (6) one arrives at

$$\mathrm{DB}_t = \beta_1 \mathrm{DB}_{t-1} + \beta_2 E_{t-1} + \beta_3 U_{t-1} + \varepsilon_t , \tag{10}$$

where $\beta_1 = 1-\gamma$ and ε_t is a disturbance term (normally distributed with zero mean) that represents neglected variables. We assume that all parameters are positive, and that β_1 is smaller than one.

Estimations of (10) have been carried out at three spatial levels: the nation, the province, and the county. Figure 2 shows the 12 provinces and 40 counties, which are listed in Table 1. For the dependent variable regionalized information is available only for the years 1977–81. Thus, the three coefficients in (10) can be estimated on the basis of only four observations, giving rise to only one degree of freedom. It is not surprising, therefore, that most estimation results give rise to very high values of the coefficients of determination R^2 and that statistically significant results are rare. The results for the national level are presented in Table 2. The parameters have been estimated by means of linear regression.

The parameters have the right sign but they are not significant at the 5% level. The value of β_3 is remarkably low: it suggests that the level of unemployment has only a marginal effect on the number of recipients of disability allowances.

Estimation results at the provincial and county levels are presented in Tables 3 and 4, respectively. Clearly, the values found for the parameters differ considerably, so the condition of perfect aggregation is not satisfied.

We will now examine to what extent a disaggregate approach leads to projections of the dependent variable that are better than those given by the macro approach. Thus we compute

$$\widehat{\mathrm{DB}}_t = \hat{\beta}_1 \mathrm{DB}_{t-1} + \hat{\beta}_2 E_{t-1} + \hat{\beta}_3 U_{t-1} \tag{11}$$

for four periods and three spatial levels. The values at the national, provincial, and county levels will be denoted by $\widehat{\mathrm{DB}}_t^n$, $\widehat{\mathrm{DB}}_t^{pi}$, and $\widehat{\mathrm{DB}}_t^{cj}$, respectively. Subsequently, we will compare $\widehat{\mathrm{DB}}_t^n$, $\sum_{i=1}^{12} \widehat{\mathrm{DB}}_t^{pi}$, and $\sum_{j=1}^{40} \widehat{\mathrm{DB}}_t^{cj}$ with the results for DB_t^n to see whether a disaggregate approach is more successful. The results are summarized in Table 5.

The table shows that in three out of four cases the calculations based on the data at county level give the most satisfactory results, followed by the provincial level and finally the national level. When we look at the differences between projections and observations, we find that the mean absolute error at the national level is 2,211. For the provincial and county levels, we find 2,075 and 1,937, respectively. This shows that the mean absolute error can be reduced by approximately 6.5% by disaggregating to the provincial level and by another 6.5% when the county level is

Figure 2 The Netherlands divided into counties.

considered.

A similar comparison between aggregate and disaggregate results can be carried out at the provincial level, since each county belongs to only one province. The results are presented in Table 6. When we leave aside the two provinces that comprise only one county, we observe that in 27 out of 40 cases (10 provinces and four time periods) the calculations at the county level give the best results, while in 13 cases an aggregate approach gives better results.

Table 1 The provinces and counties of the Netherlands.

County	Province	County	Province
1 Oost-Groningen		25 Agglomeratie Leiden	
2 Delfzijl e.o.	1 Groningen	26 Agglomeratie 's-Gravenhage	
3 Overig Groningen		27 Delft en Westland	8 Zuid-Holland
		28 Oostelijk Zuid-Holland	
4 Noord-Friesland		29 Groot-Rijnmond	
5 Zuidwest-Friesland	2 Friesland	30 Zuidoost Zuid-Holland	
6 Zuidoost-Friesland			
		31 Zeeuws-Vlaanderen	9 Zeeland
7 Noord-Drente		32 Overig Zeeland	
8 Zuidoost-Drente	3 Drente		
9 Zuidwest-Drente		33 West Noord-Brabant	
		34 Midden Noord-Brabant	10 Noord-Brabant
10 Noord-Overijssel		35 Noordoost Noord-Brabant	
11 Zuidwest-Overijssel	4 Overijssel	36 Zuidoost Noord-Brabant	
12 Twente			
		37 Noord-Limburg	
13 Veluwe		38 Midden-Limburg	11 Limburg
14 Achterhoek	5 Gelderland	39 Zuid-Limburg	
15 Arnhem/Nijmegen			
16 Zuidwest-Gelderland		40 Zuidelijke IJsselmeerpolders	12 Zuidelijke IJsselmeerpolders
17 Utrecht	6 Utrecht		
18 Kop van Noord-Holland			
19 Alkmaar e.o.			
20 IJmond			
21 Agglomeratie Haarlem	7 Noord-Holland		
22 Zaanstreek			
23 Groot-Amsterdam			
24 Gooi en Vechtstreek			

Table 2 Coefficients of (10) and R^2 at national level (with standard errors).

β_1	β_2	β_3	R^2
0.577 (0.213)	0.063 (0.025)	0.049 (0.074)	0.992

Table 3 Coefficients of (10) and R^2 at provincial level (with standard errors).

Province	β_1		β_2		β_3		R^2
1	0.106	(0.144)	0.146	(0.021)	0.187	(0.046)	0.997
2	−0.168	(0.410)	0.172	(0.056)	0.203	(0.092)	0.984
3	0.325	(0.114)	0.127	(0.018)	0.150	(0.040)	0.998
4	−2.697	(1.806)	0.522	(0.251)	0.997	(0.503)	0.982
5	0.379	(0.200)	0.096	(0.026)	0.080	(0.060)	0.991
6	0.505	(0.236)	0.069	(0.026)	0.032	(0.110)	0.971
7	0.614	(0.141)	0.057	(0.016)	0.045	(0.071)	0.991
8	0.424	(0.231)	0.060	(0.020)	0.062	(0.076)	0.981
9	0.787	(0.482)	0.030	(0.040)	0.030	(0.249)	0.971
10	0.622	(0.144)	0.057	(0.016)	0.040	(0.040)	0.998
11	1.040	(0.274)	0.017	(0.047)	−0.139	(0.121)	0.993
12	0.455	(0.166)	0.069	(0.012)	0.258	(0.092)	0.998

Table 4 Coefficients of (10) and R^2 at county level (with standard errors).

County	β_1		β_2		β_3		R^2
1	0.389	(0.111)	0.146	(0.023)	0.236	(0.061)	0.994
2	0.365	(0.135)	0.105	(0.019)	0.165	(0.053)	0.999
3	−0.364	(0.071)	0.186	(0.009)	0.194	(0.015)	1.000
4	0.190	(0.509)	0.111	(0.063)	0.124	(0.107)	0.981
5	0.178	(0.237)	0.124	(0.031)	0.206	(0.084)	0.976
6	−0.337	(0.804)	0.234	(0.133)	0.183	(0.147)	0.939
7	0.133	(0.110)	0.172	(0.020)	0.139	(0.026)	0.999
8	0.459	(0.136)	0.107	(0.021)	0.094	(0.053)	0.993
9	0.172	(0.568)	0.138	(0.084)	0.273	(0.239)	0.945
10	−0.338	(0.240)	0.176	(0.030)	0.192	(0.054)	0.987
11	−0.010	(0.577)	0.145	(0.078)	0.103	(0.095)	0.974
12	−1.674	(0.338)	0.407	(0.051)	0.903	(0.117)	0.994
13	0.116	(0.213)	0.132	(0.029)	0.148	(0.056)	0.996
14	0.327	(0.336)	0.102	(0.045)	0.141	(0.109)	0.991
15	0.433	(0.188)	0.088	(0.023)	0.050	(0.060)	0.981
16	0.566	(0.043)	0.084	(0.006)	0.003	(0.013)	1.000
17	0.505	(0.236)	0.069	(0.026)	0.032	(0.110)	0.971
18	0.473	(0.000)	0.083	(0.000)	0.123	(0.000)	1.000
19	0.604	(0.047)	0.063	(0.006)	0.084	(0.016)	1.000
20	1.090	(0.236)	−0.001	(0.022)	−0.032	(0.139)	0.991
21	0.443	(0.153)	0.104	(0.023)	0.038	(0.118)	0.951
22	0.937	(0.144)	0.026	(0.015)	−0.115	(0.104)	0.991
23	0.547	(0.142)	0.061	(0.014)	0.037	(0.074)	0.989
24	0.819	(0.001)	0.032	(0.000)	−0.045	(0.001)	1.000
25	0.095	(0.128)	0.111	(0.014)	0.111	(0.037)	0.994
26	−0.058	(0.341)	0.103	(0.029)	0.107	(0.122)	0.859
27	0.610	(0.182)	0.038	(0.013)	0.023	(0.103)	0.974
28	0.549	(0.182)	0.044	(0.014)	0.102	(0.061)	0.997
29	0.698	(0.175)	0.034	(0.015)	0.010	(0.050)	0.991
30	0.479	(0.171)	0.062	(0.016)	0.061	(0.070)	0.993
31	0.968	(0.409)	0.020	(0.032)	−0.116	(0.263)	0.979
32	0.683	(0.515)	0.036	(0.045)	0.091	(0.213)	0.970
33	0.696	(0.186)	0.044	(0.021)	0.040	(0.043)	0.998
34	0.490	(0.085)	0.015	(0.009)	0.062	(0.031)	0.998
35	0.508	(0.181)	0.015	(0.021)	0.063	(0.057)	0.995
36	1.114	(0.077)	−0.006	(0.009)	−0.078	(0.020)	1.000
37	2.025	(0.023)	−0.127	(0.003)	−0.490	(0.007)	1.000
38	1.130	(2.695)	−0.000	(0.473)	−0.168	(0.503)	0.932
39	0.715	(0.475)	0.070	(0.083)	0.082	(0.308)	0.962
40	0.445	(0.166)	0.069	(0.012)	0.258	(0.092)	0.998

Table 5 Comparison of national, provincial, and county projections.

	1978	1979	1980	1981
DB_t^n	557,493	586,327	618,201	635,904
$DB_t^n - \widehat{DB}_t^n$	22	−2,861	4,375	−1,588
$DB_t^n - \sum_{i=1}^{12} \widehat{DB}_t^{pi}$	31	−2,777	4,105	−1,393
$DB_t^n - \sum_{j=1}^{40} \widehat{DB}_t^{cj}$	77	−2,618	3,787	−1,261

Table 6 Comparison of provincial and county projections.

Province		1978	1979	1980	1981
1	DB_t^{p1}	26,046	26,909	28,298	28,853
	$DB_t^{p1} - \widehat{DB}_t^{p1}$	−50	−10*	111	−54
	$DB_t^{p1} - \sum_{i=1}^{3} \widehat{DB}_t^{ci}$	−28*	−15	73*	−31*
2	DB_t^{p2}	21,140	21,910	23,024	23,859
	$DB_t^{p2} - \widehat{DB}_t^{p2}$	131*	32*	−244	94
	$DB_t^{p2} - \sum_{i=4}^{6} \widehat{DB}_t^{ci}$	230	−65	−235*	92*
3	DB_t^{p3}	18,514	19,423	20,669	21,478
	$DB_t^{p3} - \widehat{DB}_t^{p3}$	−23*	−41	98*	−37*
	$DB_t^{p3} - \sum_{i=7}^{9} \widehat{DB}_t^{ci}$	−39	−30*	111	−42
4	DB_t^{p4}	41,109	43,875	46,306	47,496
	$DB_t^{p4} - \widehat{DB}_t^{p4}$	−203	−215*	582	−183
	$DB_t^{p4} - \sum_{i=10}^{12} \widehat{DB}_t^{ci}$	−25*	−221	358*	−119*
5	DB_t^{p5}	67,503	70,590	74,018	75,540
	$DB_t^{p5} - \widehat{DB}_t^{p5}$	−24*	−291	476	−169*
	$DB_t^{p5} - \sum_{i=13}^{16} \widehat{DB}_t^{ci}$	−26	−272*	465*	−173
6	DB_t^{p6}	35,510	37,405	39,489	40,631
	$DB_t^{p6} - \widehat{DB}_t^{p6}$	120	−448	465	−134
	$DB_t^{p6} - \widehat{DB}_t^{c17}$	120	−448	465	−134
7	DB_t^{p7}	98,685	104,368	110,329	113,865
	$DB_t^{p7} - \widehat{DB}_t^{p7}$	118	−663	789	−247
	$DB_t^{p7} - \sum_{i=18}^{24} \widehat{DB}_t^{ci}$	102*	−580*	673*	−200*
8	DB_t^{p8}	99,073	102,914	107,488	109,754
	$DB_t^{p8} - \widehat{DB}_t^{p8}$	50	−650	888	−293
	$DB_t^{p8} - \sum_{i=25}^{30} \widehat{DB}_t^{ci}$	47*	−589*	809*	−271*
9	DB_t^{p9}	9,701	10,296	11,178	11,622
	$DB_t^{p9} - \widehat{DB}_t^{p9}$	−38	−99	218	−84
	$DB_t^{p9} - \sum_{i=31}^{32} \widehat{DB}_t^{ci}$	−34*	−97*	205*	−77*
10	DB_t^{p10}	76,889	81,683	86,685	89,776
	$DB_t^{p10} - \widehat{DB}_t^{p10}$	−82*	−132	354	−149
	$DB_t^{p10} - \sum_{i=33}^{36} \widehat{DB}_t^{ci}$	−99	−99*	321*	−133*
11	DB_t^{p11}	61,779	65,045	68,415	70,037
	$DB_t^{p11} - \widehat{DB}_t^{p11}$	20*	−285	412*	−151*
	$DB_t^{p11} - \sum_{i=37}^{39} \widehat{DB}_t^{ci}$	−182	−226*	589	−189
12	DB_t^{p12}	1,544	1,909	2,392	2,993
	$DB_t^{p12} - \widehat{DB}_t^{p12}$	12	25	−44	14
	$DB_t^{p12} - \widehat{DB}_t^{c40}$	12	25	−44	14

* Smallest difference between observed and computed values.

5. Concluding Remarks

This contribution has considered the explanation of aggregate variables by means of disaggregated data. The choice of aggregation level depends on the problem under consideration. We gave some reasons why a disaggregate approach does not necessarily produce better results than an aggregate one. In particular, when the phenomenon being studied has a top-down structure, an aggregate approach may be preferable. For the numerical application we selected a case for which a bottom-up structure is most plausible and found that a disaggregate approach leads to somewhat better results. The small number of observations did not allow the testing of alternative model specifications. For example, we did not deal with interregional linkages (White and Hewings 1982).

We conclude that in spatial studies the information obtained for analytic, planning, and forecasting issues may be highly sensitive to shifts in the level of spatial aggregation. In order to test this sensitivity, simulation experiments such as that reported here are essential.

References

Akdeniz, F., and G. Milliken (1975) The relationship between macro and micro parameters. *International Economic Review* 16:511–515.

Alker, H.R., Jr. (1969) A typology of ecological fallacies. *Quantitative Ecological Analysis in the Social Sciences*, eds. M. Dogan and S. Rokkan (Cambridge, MA: MIT Press), pp. 69–86.

Baumann, J., M.M. Fischer, and U. Schmidt (1983) Multiregional labor supply models for Austria: The effects of different regionalizations in multiregional labor market modeling. *Papers of the Regional Science Association* 52.

van den Bosch, F.A.J., and C. Petersen (1982) An explanation of the growth of social security disability transfers. *Paper* presented at Symposium on Some Economic Aspects of Disability, Erasmus University, Rotterdam, October 1981.

CBS (1977–81a) Sociale maandstatistieken. *Report*, Centraal Bureau voor de Statistiek, Voorburg.

CBS (1977–81b) Statistiek werkzame personen. *Report*, Centraal Bureau voor de Statistiek, Voorburg.

Courbis, R. (1982) Multiregional modeling: A general appraisal. *Regional Development Modeling: Theory and Practice*, eds. M. Albegov *et al.* (Amsterdam: North-Holland), pp. 65–84.

van Daal, J. (1980) On aggregation of economic relationships. *Report*, Erasmus University, Rotterdam (revised).

Fischer, M.M. (1982) Eine Methodologie der Regionaltexonomie: Probleme und Verfahren der Klassifikation und Regionalisierung in der Geographie und Regionalforschung. Bremer Beiträge zur Geographie und Raumplanung, Schwerpunkt Geographie, Universität Bremen, Bremen.

GMD (1977–81) Regionale gegevens AAW- en/of WAO-uitkeringsgenietenden. *Report*, Gemeenschappelijke Medische Dienst, Amsterdam.

Green, H.A.J. (1977) Aggregation problems of macroeconomics. *The Microeconomic Foundations of Macroeconomies*, ed. G.C. Harcourt (London: Macmillan), pp. 179–194.

Grunfeld, Y., and Z. Griliches (1960) Is aggregation necessarily bad? *Review of Economics and Statistics* 42(1):1-13.

Harvey, D. (1969) *Explanation in Geography* (London: Arnold).

Hordijk, L. (1979) Problems in the estimation of econometric relations in space. *Papers of the Regional Science Association* 42:99–118.

Kelejian, H.H. (1980) Aggregation and disaggregation of nonlinear equations. *Evaluation of Econometric Models*, eds. J. Kmenta and J.B. Ramsey (New York, NY: Academic Press), pp. 135–152.

Lohmoeller, J.B., J.W. Falter, A. Lind, and J. de Rijke (1983) Unemployment and the rise of national socialism: Contradicting results from different regional aggregations. *Paper* presented at Workshop on Analysis of Qualitative Spatial Data, Free University, Amsterdam.

Nijkamp, P., and P. Rietveld (1982) Structure analysis of spatial systems. *Multiregional Economic Modeling: Practice and Prospect*, eds. B. Issaev *et al.* (Amsterdam: North-Holland), pp. 35–48.

Openshaw, S., and P.J. Taylor (1981) The modifiable areal unit problem. *Quantitative Geography: A British View*, eds. R.J. Bennett and N. Wrigley (London: Routledge and Kegan Paul), pp. 60–69.

Orcutt, G., H. Watts, and J. Edwards (1968) Data aggregation and information loss. *American Economic Review* 58:773–787.

Theil, H. (1954) *Linear Aggregation of Economic Relations* (Amsterdam: North-Holland).

White, E.N., and G.J.D. Hewings (1982) Space–time employment modeling: Some results using seemingly unrelated regression estimates. *Journal of Regional Science* 22(3):283–302.

PART

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CHAPTER 14

Interactive Systems for Regional Analysis of Industrial Sectors

Börje Johansson and **Bertil Marksjö**

1. Introduction

This chapter describes two information systems that generate regional information about industrial plants and firms, respectively, in Sweden. SIND-data* is installed in the National Industrial Board; SUPPORT has a stronger orientation toward decision makers in business corporations. Both systems are used for regional planning, impact studies, and forecasting. The chapter focuses on the methods and foundations for constructing and designing information systems like SIND-data and SUPPORT. It also reports on some of the different ways in which the systems and their dialogue and graphic options may be utilized.

The SIND-data system may be used to outline the contents of the chapter. This system contains, for example, information about how production techniques, productivity, and profitability of establishments belonging to a given sector are distributed in a region. In Sweden, as in many other countries, there exists a confidentiality criterion that prohibits information about individual units from being made public. To satisfy this criterion, establishments have to be grouped together. Section 2 outlines how this problem has been approached by means of a filter process. Section 3 describes this process in mathematical form, as well as its general features. The method arranges the original data in groups that satisfy requirements of (i) confidentiality, (ii) aggregation consistency, (iii) group homogeneity, and (iv) distribution accuracy.

We also describe in Section 2 how the design of the systems has been guided by the requirements that (i) the information shall be reliable for the purpose to which it is put, and (ii) its expected degree of uncertainty shall be measurable and known. These principles are observed by

* A similar system, called NIND-data, exists in Norway.

organizing the information in the form of distributions that are structurally invariant over long periods.

Statistical theory and economic theory, together with estimated invariances, become integral parts of the information system by being introduced during its design.

2. User Requirements, Theory, and Estimated Invariances

2.1. *Principles for Designing an Information System*

Information systems may be looked upon and evaluated from different perspectives. In what follows we shall interpret them as systems for decision support (e.g. Marschak 1974). The following ways of utilizing an information system have been identified by Nijkamp (1982):

- description, monitoring, and *ex post* evaluation
- impact analysis, scenario projections, and forecasts
- decision analysis, evaluation of options, and planning.

If the user is an organization that makes diagnoses and forecasts, these activities will represent the decision making of the user. Basic user requirements of an information system are accessibility and reliability of the information, flexibility of the system (multipurpose use of information), and relevance to decision making.

Users of information systems often reveal an anxious fixation on obtaining information with a high degree of "actuality." This property depends not only on the time lag between the occurrence of an event and the observation/recording of the event in the information system. One may also distinguish between "perishable" and "durable" information, where the latter retains its "actuality" for longer. Durable information will generally refer to decision-relevant structural features of a regional system. We may refer to this as information about structural invariances.

Although time-invariant information is usually obtained by processing time sequences of observations, we may still illustrate the basic idea with Figure 1. This figure depicts the trade-off between reducing the observation lag A and increasing the invariance interval B within which the information can be regarded as reliable.

We shall present two different information systems, both of which were set up with the ambition of satisfying two criteria: it was required that the information should have a form that made it decision-relevant and that gave it a high degree of invariance so that interval B in Figure 1 could be extended. Moreover, the degree of reliability and invariance was measured and analyzed for the type of information that could be generated by the system.

The following approach was selected. The original data set is transformed to distributions for which the degree of invariance can be evaluated over time. In the SIND-data system the distributions refer to

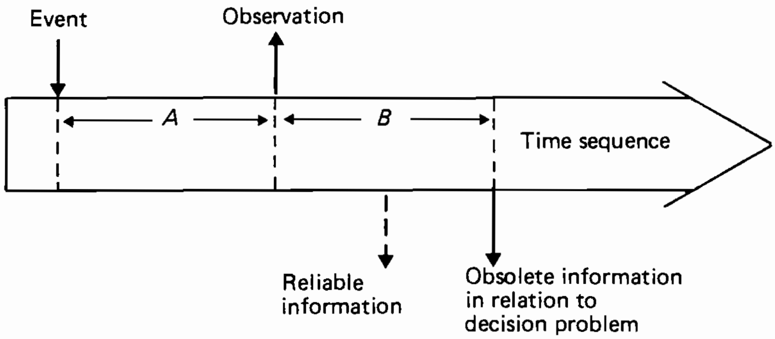


Figure 1 Trade-off between observation lag A and invariance (reliability) interval B.

characteristics of industrial establishments (production units). The other system, SUPPORT, refers to industrial firms, where a firm (as distinct from a production unit) represents a decision-making and financially defined unit. For each firm one can always identify one or several establishments belonging to it. Data referring to individual establishments and firms are regarded as confidential in Swedish statistical systems.

In order to satisfy simultaneously the criteria of invariance and confidentiality,* the systems are updated annually in the Central Bureau of Statistics (SCB). There, confidential data may be used to evaluate invariances and to transform the original data into a model of the data (MD). The MD is designed in such a way that it satisfies all confidentiality criteria with "minimum loss of information." Thereafter, the MD can be transferred to users outside the bureau as an integral part of the information system. In this sense the model is an input to the production of information with the information system. The procedure is illustrated in Figure 2.

A more explicit illustration of the data transformations in Figure 2 is given in Figure 3. This figure shows the path from raw data to decision support information.

The difficulties of designing a multipurpose information system can be seen from Figure 3. To have some success it is essential to know the decision context before designing the filtering process according to confidentiality rules and invariance criteria. For the SIND-data system, sorting is made with regard to the ratio between wage and value added (wage share) of each unit, and the filter is used for each regional level. To be more specific, in order to include regions A, B, and $A \cup B$ in data set (3) of Figure 3, three separate "filtering runs" are necessary. If the nonconfidential aggregates in set (3) are required to contain units with similar capital costs instead of wage shares, then another filter process

* The confidentiality criterion requires that observation units are ordered in groups. Such a group can never contain less than three units. Section 3 gives a definition of the criterion.

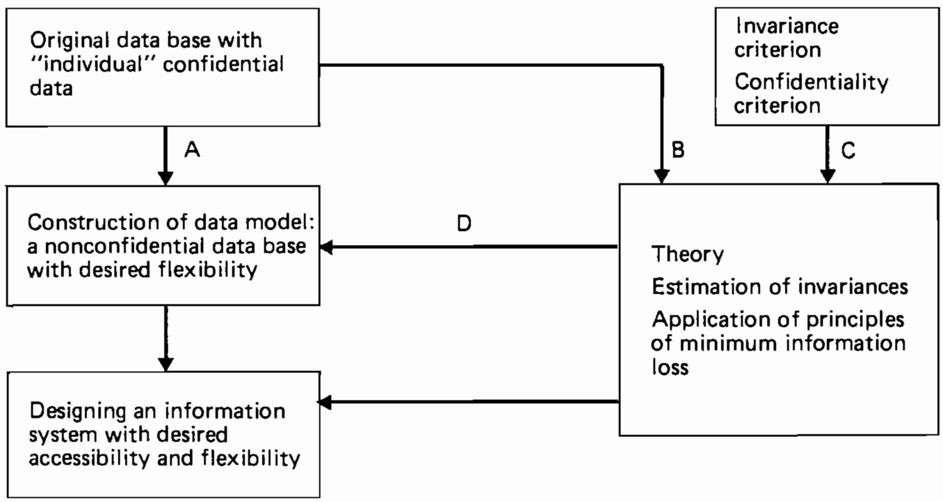


Figure 2 Designing and updating the information system. When confidential data are used, operations A to D have to be done inside the Central Bureau of Statistics.

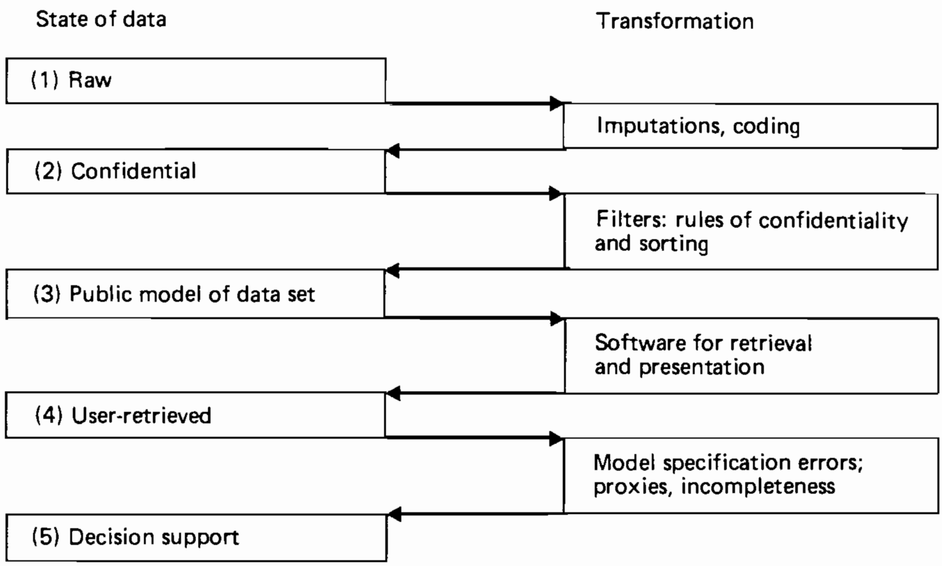


Figure 3 Stages of data transformation.

has to be applied.*

* The SUPPORT system contains separate models of the data set based on (i) sorting by wage share and (ii) sorting by rate of return; capital cost information can be retrieved from both models.

2.2. *Specification of Variables for Regions and Sectors*

The preceding section described a method for designing two information systems so that certain criteria were satisfied. Both systems have also been designed in such a way that information is generated for different levels of spatial and sectoral aggregation, and in a form that makes it possible to separate short-term variations and structural changes.

Three types of geographic subdivision exist. These are the nation, the industrial region, and the county. There are six industrial regions; each of them consists of several counties. The total number of counties is 24.

The SIND-data system contains about one hundred sectors of the manufacturing and mining industries. These sectors can be aggregated in different ways. With certain combinations between region and sector it is not possible to generate any information because of confidentiality restrictions. Then the system offers two options. One is to retain the finer-sector level and enlarge the region through spatial aggregation. The other is to aggregate several sectors at the initially given regional level.

Each type of distribution generated by the system may be presented either as a table or as a diagram. A diagram can have either of the basic forms shown in Figure 4. Each diagram includes two distribution curves, which may be selected in continuous, smooth form or in a discrete, step-function form. Curves A and B can compare either two different years for the same region, or two different regions in the same year (e.g. county compared with nation). In this way a series of comparisons may be obtained that makes it possible to separate fluctuations from structural changes.

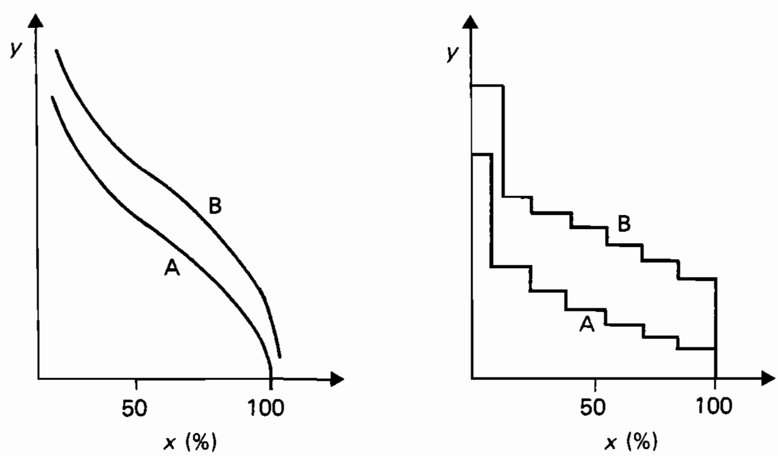


Figure 4 Two types of distribution diagram.

For both SIND-data and SUPPORT there exist several choices of the variables x and y in Figure 4. The following alternatives are used frequently in SIND-data:

y: productivity (value added per number of persons employed), or profit margin (gross profit per sales value), or wage share (total labor costs per value added) ($1-y$ then represents profit share).

x: cumulative share (%) of (i) persons employed, or (ii) value added, or (iii) sales value in sector or region.

The absolute value of the x variable may be obtained separately. The cumulative share scale has been chosen in order to facilitate comparison of structural properties.

The SUPPORT system contains a rich variety of options for x and y. In addition to the options for SIND-data, the variable y may, for example, represent investment, rate of return on total capital and owners' capital, proportion of foreign capital, interest rate with regard to foreign capital, and turnover rate; and x may also represent value of total capital, owners' capital, number of firms or of persons employed, etc.

2.3. *Production Theory and Productivity Measures*

Since many features are similar for the two systems we shall concentrate on the SIND-data system, in which establishments are the units of observation. In this case it is straightforward to apply a classical type of production theory.

The theoretical background may be summarized as follows. A production unit is characterized by its different types of durable resources, which are formed into an organization embodying the operation technique (production, distribution, etc.). The technique represents a time-invariant property of the production unit; it can only be changed by means of investment efforts. This also means that value added, at fixed prices, per number of persons employed (labor productivity) remains unchanged in the absence of investments.

In general, renewal investment in existing units is a slow process. This means that the productivity parameter $\bar{\mu}_{jr}^{\tau}$ will also change slowly; $\bar{\mu}_{jr}^{\tau}$ denotes the productivity of units in sector j and region r that are applying technique τ when the units operate at full capacity. However, the annually observed productivity μ_{jr}^{τ} will fluctuate as a result of variations in utilization of capacity.

The structural invariance of the distribution of productivity over employment in each sector and region has been examined by means of the following type of combined cross-section and time-series estimation:

$$z = \left[1 + \exp\left(a_0 + a_1\mu + a_2 t\right)\right]^{-1} \tag{1}$$

where $z = z(\mu, t)$ denotes the fraction of the number of persons employed in establishments with a productivity equal to or higher than μ, where t is a time index (years) and a_0, a_1, and a_2 are estimated parameters. The logistic type of function in (1) gives an acceptable description of the actual distributions over the period 1968–78 for specific sectors and regions. When observations of extremely high values of μ and values of z of 0.9999 or above ($0 \leq z \leq 1$) were eliminated, it was possible to obtain for most sectors a value of R^2 (coefficient of multiple correlation) ranging between 0.8 and 0.9 at the national level and between 0.6 and 0.85 with regard to industrial regions (Appendix 1).* When evaluating the invariance property one should observe that three parameters for each z function generate ten different productivity curves of the type illustrated in Figure 5. Certain sectors in some regions display an invariance below the average. In those cases the growth rate of μ is unevenly distributed over different segments of the curve.

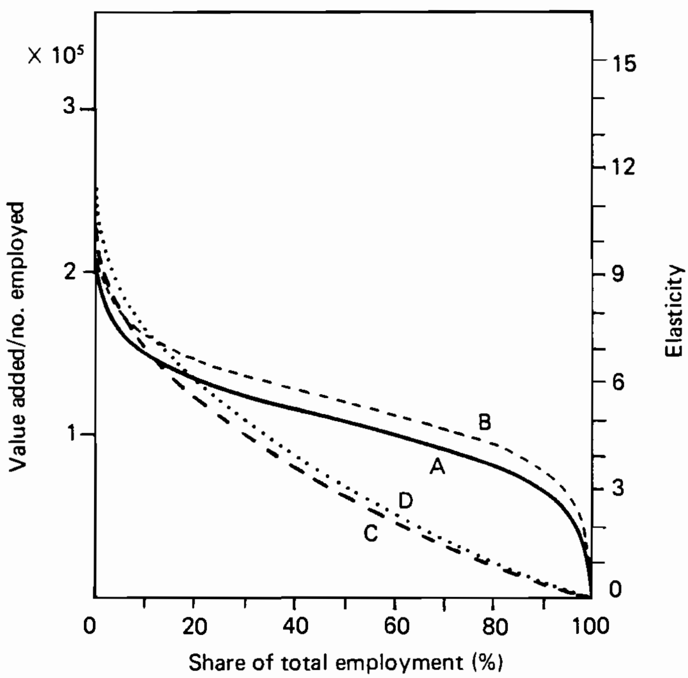


Figure 5 Continuous productivity and elasticity functions for the graphics industry in Southern Sweden during 1968–78 (1975 prices). Curve A: value added, 1978; B: value added, 1985; C: elasticity, 1978; D: elasticity, 1985.

* For most sectors values of μ exceeding 300 were eliminated. This corresponds to 300,000 in Figure 5.

2.4. *Structural Invariance and Gross Profits*

For each establishment we may write

$$\mu(t) = W(t)/S(t) + B(t)/S(t) , \qquad (2)$$

where $W(t)$ denotes labor costs, $B(t)$ gross profits, and $S(t)$ the number of persons employed. If $\mu(t)$ exhibits invariance then the fixed-price values of $W(t)$ and $B(t)$ should change slowly on average. There are two reasons for examining the variance of $B(t)$ and, in particular, the profit share $B(t)/F(t)$, where $F(t) = \mu(t)S(t)$ denotes value added in an establishment. Firstly, one of the curves generated by the information system describes the distribution of profit share over value added. The other reason is that for the SIND-data system the model of the original data set is constructed by forming groups of establishments that have approximately the same profit share. If the share B/F is approximately invariant in the production units, then the units will have the same relative position on a given type of curve over time.

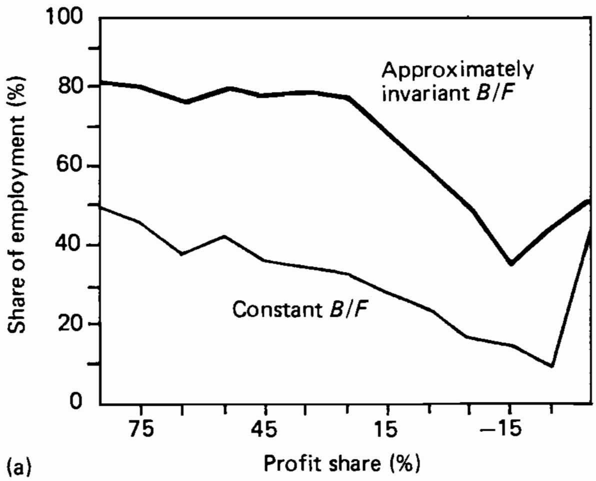
The degree of invariance for different profit levels displays the same pattern for the different sectors of industry in Sweden. As illustrated for the whole manufacturing industry in Figure 6, the invariance is large at high and medium profit levels. When the profit is reduced and becomes negative, the invariance decreases. One reason for this is, of course, that when such units are not shut down but retained, it is desirable for the owners to invest in new techniques so that the profit situation is improved. The ratio B/F is characterized in Figure 6 as approximately invariant if it varies by less than 10% between consecutive years.

The examination of the invariance properties of the information that can be processed through the SIND-data system is to a large extent based on a complete transition analysis showing how productivity and profit share change for units between years (e.g. Johansson and Holmberg 1982).

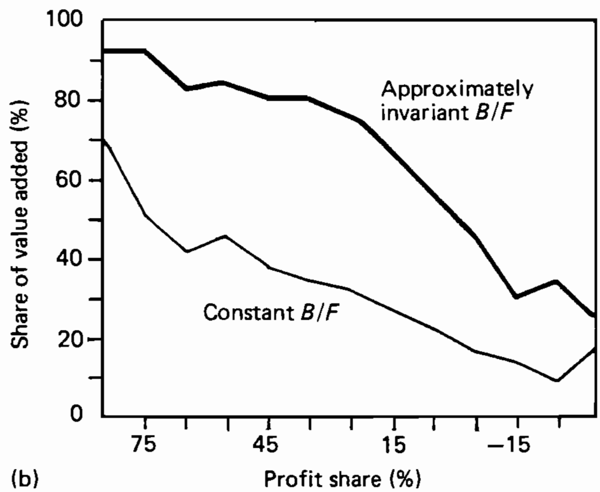
2.5. *Interactive and Noninteractive Parts of the Systems*

Both SIND-data and SUPPORT have (i) an interactive part with a high-access dialogue system and (ii) a noninteractive part from which information is obtained on request. For this second part there is no dialogue system and access is low.

The interactive part of each system produces diagrams and tables of the kind already described. This output can be evaluated and interpreted with the help of associated models. Besides the type of invariance measures described earlier, it provides information about the intensity of exit and entry processes and the probability of a future loss in view of the current productivity and profit share. The probability of exit, i.e. shutdown of establishments, is estimated using functions with the following exponential form:



(a)



(b)

Figure 6 (a) Share of persons employed and (b) share of value added in units of Swedish manufacturing industry (1968–78) for which the profit share B/F varies by less than 10% between years (source: Strömqvist 1983a).

$$\xi = \alpha \exp(\beta W/F), \tag{3}$$

where ξ denotes the annual probability that a unit with wage share W/F will be shut down; α and β are estimated, positive parameters. According to (3), the frequency of shutdown is also positive for units with positive profits.

Figure 7 describes the probability of transition from a positive profit level to a situation of loss. The curve refers to establishments in the industry as a whole.

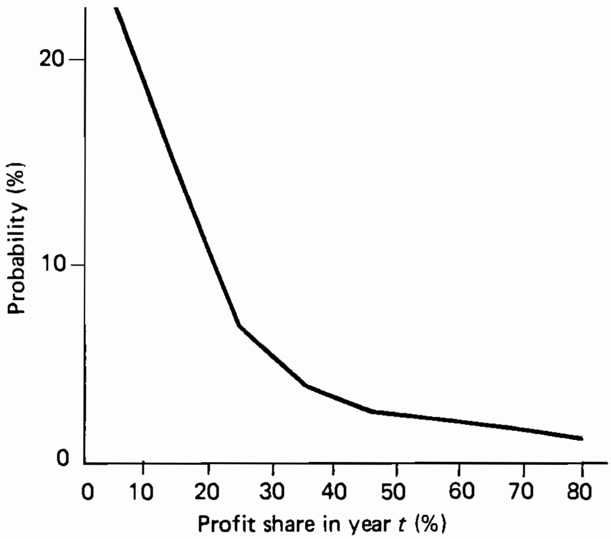


Figure 7 The probability that a person employed in a unit with positive profit in year t will be employed in a unit with negative profit in year $t+1$.

Figure 8 gives an overview of the SIND-data system. Most of the features are also valid for SUPPORT, but SUPPORT contains many more options than SIND-data. The output from the interactive part of the system is used, for example,

- to detect and evaluate structural change in regions and sectors,
- to predict the likelihood of shutdown in a 2–5-year perspective, and
- to project the regional impact of changes in price and wage levels.

This means that tables and diagrams are interpreted with the help of associated models of the kind described earlier. A description of the dialogue access is given in Appendix 2.

Using the noninteractive part of the information system, one may describe certain input coefficients (production technique) of establishment groups for each sector in a region. This information is extracted for each group of units from data on (i) labor force and labor costs, (ii) use of oil products (cost and quantity), (iii) use of electricity (cost and quantity), and (iv) other input costs. Together with information about production these data are used to assess and forecast the change of production techniques for different segments of a productivity curve.

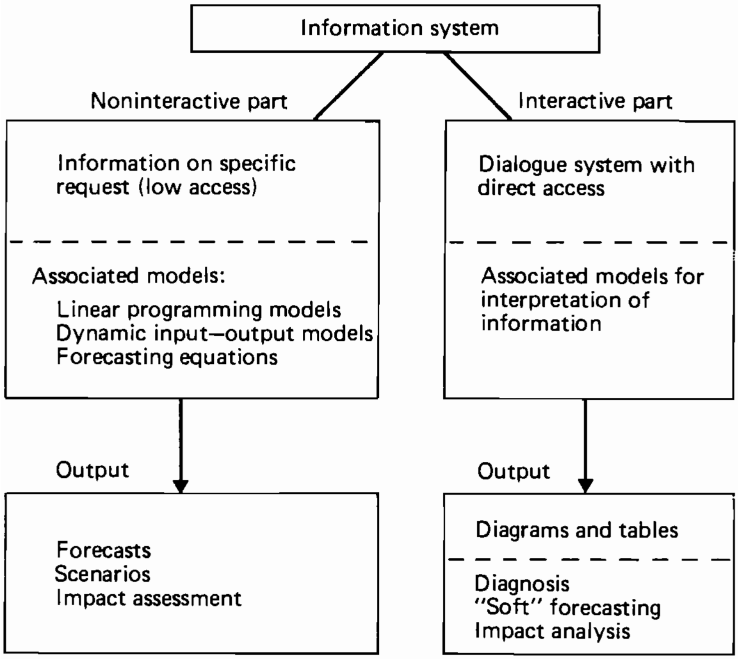


Figure 8 Overview of SIND-data.

Some of the models in the noninteractive part of the system have been described in English. Programming models are described by Johansson and Strömqvist (1981), Johansson (1983), and Strömqvist (1983b). The input–output model system MACROINVEST is described by Persson and Johansson (1982).

3. Design Criteria and Confidentiality

3.1. *Confidentiality and Types of Aggregation*

Confidentiality is a broad concept that can be defined in various ways, depending on the context. For statistical systems, however, it denotes a principle of not exposing any observation unit to the public. The principle is applicable for all features of a unit that are guaranteed privacy during data collection. In the case of profitability statistics the observation units are production units (establishments) or business units (firms).

In Sweden this type of statistic is not allowed to be used in its original form outside the government agency "Statistics Sweden."* If the observation units are "sufficiently aggregated" into observation groups, the resulting statistical system can be used without constraints outside the agency,

* Official Statistics of Sweden, National Central Bureau of Statistics.

and one is allowed to process and disseminate information from it. The criterion "sufficiently aggregated" can be deduced from the confidentiality rule, which says:

> The accumulative sales value of a permissible group should be more than twice the sales value of any observation unit within that group.

From this rule one can conclude that a permissible group must contain at least three observation units, since in a group of two units the larger unit would contribute at least 50% of the sales value in the group, and this makes the group not permissible.

Groups may be formed by means of optimization techniques provided that it is possible to rank different groupings on the same scale. Following this approach, we have introduced an objective that requires that the information lost during aggregation should be minimal, subject to the confidentiality rule and certain homogeneity constraints on the groups. The information loss concept will be developed in the next section; the homogeneity constraints are discussed below.

The SIND-data system utilizes a less complicated model of the original data set than the SUPPORT system. Therefore, we shall use the properties of SIND-data to shed light on the general aspects of reshaping the original data set into a nonconfidential register. One of the purposes of SIND-data is to study profitability. Because of this, it is desirable to make the groups in the register as homogeneous as possible with respect to profitability. This means that the profit share B/F of each production unit in a group should be approximately the same.

Alternative principles of group homogeneity could be formulated with regard to the number of persons employed, amount of capital, degree of export orientation, etc. Measuring homogeneity in several ways makes the process of constructing groups more complex, since then it becomes necessary to evaluate the trade-offs between these different aspects. In the SUPPORT system one type of register is constructed for each type of homogeneity measure. The various registers can then be used to process combined information. The SIND-data system utilizes only the profit share variable by which to measure homogeneity.

In SIND-data, establishments are observation units, and each such unit has a given location. In this case it is convenient to form a separate register for each combination of region, economic sector, and year. We shall now describe how a single register of this type is obtained. Hence, the presentation concentrates on an aggregation scheme using one variable.

The aggregation procedure can be visualized as a manufacturing process producing permissible (nonconfidential) groups with observation units as inputs. In order to obtain homogeneous groups with regard to a certain variable, in this case profitability, we sort the observation units along a unit line, ordered according to the value of B/F.

In the assembly phase one unit at a time is moved from the front of the unit line to the end of an assembly line. As soon as the units in the assembly line fulfill the confidentiality rule, they are appended as a new group in a group line. The process is repeated until the unit line is empty. Figure 9 illustrates the aggregation process.

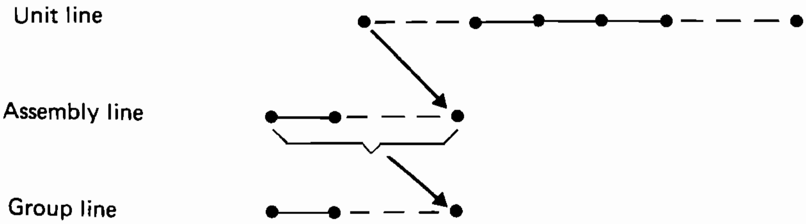


Figure 9 The assembly phase of the aggregation procedure.

When the assembly phase has ended, in the sense that no more groups can be obtained, it may happen that the assembly line is not yet empty. The reason will be that the remaining units do not satisfy the confidentiality rule. In such a case a disassembly phase has to be started, as described in Figure 10. The last group on the group line is moved to the assembly line and is disassembled. This process is repeated until the units on the assembly line form a group fulfilling the confidentiality rule.

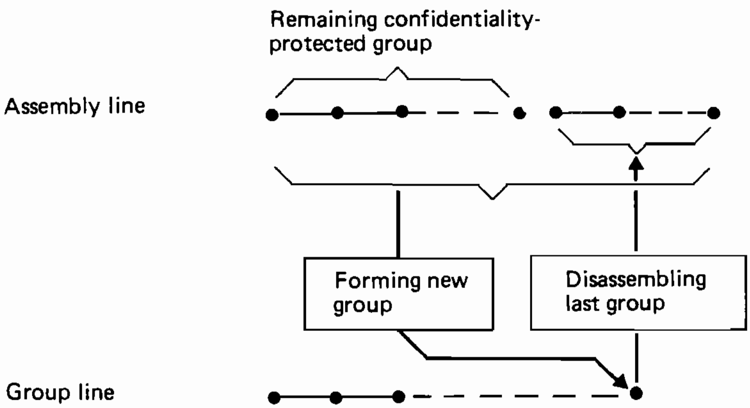


Figure 10 The disassembly phase of the aggregation procedure.

In the degenerate case the group line becomes empty during disassembly, so it is not possible to extract any information about even one group. In all nondegenerate cases the group line finally consists of units aggregated into a sequence of groups.

3.2. *Criterion of Minimum Information Loss*

In the filtering process described in the previous section we obtain a set of groups representing the original set of units. We would like this process to have the following characteristics:

- The process should use a *weight* variable such that the group weight equals the sum of weights of the units within the group (value added in the case of SIND-data).
- It should use a *confidentiality* variable for which the largest value within a group is less than half the sum over the group (sales value in the case of SIND-data).
- It should use a *homogeneity* variable that varies as little as possible within each group (wage share in the case of SIND-data) (if y is wage share, profit share is $1-y$).
- The distribution of weighted homogeneity over the groups should be as close as possible to the same distribution over units (wages/labor costs in the case of SIND-data).

A common underlying principle can be used to promote the second and third characteristics, whenever they do not conflict. The principle has its origin in statistical theory. A brief summary is given below.

Let us suppose that in a statistical experiment n different outcomes are possible. These events are numbered $j=1,2,\cdots,n$ and the probabilities, $p_j>0$, that they occur add up to 1. Let P denote this type of probability distribution. Kullback (1959) has defined an asymmetric measure of the difference between two probability distributions P and Q. He defines the information gain of P over Q as

$$I(P;Q) = \sum_{j=1}^{n} p_j \ln(p_j / q_j) \,. \tag{4}$$

We choose in this context to interpret $I(P;Q)$ as the information loss from Q to P, where Q is called the *a priori* distribution and P is called the *a posteriori* distribution. In this application we would like to give the attributes *a priori* to the observation units and *a posteriori* to the groups formed during the filtering process.

Let W denote the weight variable and H the homogeneity variable. The number of units is n and the number of groups is m. If H is scaled properly, the *a priori* probabilities Q are given by

$$q_j = h_j w_j \quad \text{for } j = 1,2,\ldots,n \;. \tag{5}$$

From now on we require that h_j and w_j are greater than zero for all j. Let the groups be indexed by J such that $J=1,2,\cdots,m$ where J, at the same time, denotes a set of unit indices $\{j_1, j_2, j_3, \cdots\}$ showing to which group a certain unit belongs. We assume that every unit belongs to some group, and that no unit belongs to more than one group. This type of grouping will be called *complete*.

The variables corresponding to H and W, but varying over the groups, are denoted by $\bar{H}$ and $\bar{W}$. Then by definition:

$$\bar{w}_J = \sum_{j \in J} w_j \text{ for } J=1,2,\ldots,m . \tag{6}$$

We prescribe that

$$\bar{h}_J = \bar{h}_j \text{ when } j \in J \text{ for } J=1,2,\ldots,m . \tag{7}$$

Then we can define the *a posteriori* probabilities P over the units by

$$p_j = \frac{\bar{h}_j w_j}{\sum_{k=1}^{n} \bar{h}_k w_k} \text{ for } j=1,2,\ldots,n . \tag{8}$$

In the general case, $\bar{h}_j \neq h_j$.

Now the information loss criterion can be stated as follows:

Among all complete groupings of units, find the one that minimizes $I(P;Q)$, where Q is defined in (5) and P is expressed in a short-hand form of (8) as

$$p_j = x_J w_j \quad \text{when } j \in J \text{ and } J=1,2,\ldots,m , \tag{8a}$$

such that

$$I(P;Q) = \sum_{j=1}^{n} x_J w_j \ln(x_J w_j / h_j w_j), \quad j \in J,$$

subject to the following simultaneous conditions:

(1) $x_J > 0$ for $J = 1,2,\ldots,m$,

(2) $\sum_{j=1}^{n} x_J w_j = 1$, where $j \in J = 1,2,\ldots,m$,

(3) $2\max_{j \in J}(s_j) < \sum_{j \in J} s_j$ for $J = 1,2,\ldots,m$,

where S is the confidentiality variable.

Given a permissible complete grouping the Lagrange function $L(x)$ of the problem is

$$L(x) = \sum_{J=1}^{m} \sum_{j \in J} x_J w_j \ln(x_J / h_j) + \lambda\left[1 - \sum_{J=1} \sum_{j \in J} x_J w_j\right]. \tag{9}$$

The first-order conditions for a minimum are $\partial L / \partial x_J = 0$ for $J = 1,2,\cdots,m$. Differentiation yields

$$\sum_{j \in J}\left[w_j \ln(x_J / h_j) + w_j - \lambda w_j\right] = 0.$$

Summation gives

$$\bar{w}_J \ln x_J + \bar{w}_J(1-\lambda) - \sum_{j \in J} w_j \ln h_j = 0.$$

Hence

$$x_J = \exp(\lambda - 1)\prod_{j \in J} h_j^{w_j / \bar{w}_J}. \tag{10}$$

We observe that $x_j > 0$ for $J = 1,2,\ldots,m$ since $h_j > 0$ for $j = 1,2,\ldots,n$.

The second-order conditions are

$$\frac{\partial^2 L}{\partial x_K \partial x_J} = \frac{\bar{w}_J}{x_J}\delta_{JK},$$

where $\delta_{JK} = 1$ if $J = K$ and $\delta_{JK} = 0$ otherwise. Since $x_J > 0$, a minimum is obtained because $\bar{w}_J > 0$.

Appendix 1: Combined Time-Series and Cross-Section Estimates of Productivity Distributions

Estimates of the productivity curves are obtained directly from the SIND-data system. The currently used estimation method differs somewhat from that described here. Table 1 presents results for two of the several estimation procedures that were initially utilized on the original data set. Results are presented for the 14 major industrial sectors on the national level. In addition we give results for the industry as a whole with regard to the six industrial regions.

Table 1 Measures of estimation accuracy. All parameters have significant t-values.

	Estimation alternative			
	I		II	
Industrial sector on national level	F-value	R^2	F-value	R^2
Manufacturing (whole)	71,387	0.91	35,596	0.84
Mining	35	0.34	98	0.67
Food	3,479	0.80	2,746	0.77
Textiles	7,572	0.88	3,914	0.79
Wood products	12,371	0.87	14,452	0.88
Paper and pulp	409	0.65	727	0.78
Printing and publishing	3,994	0.87	5,624	0.90
Chemicals	957	0.79	1,772	0.89
Stone and clay	2,860	0.83	2,193	0.79
Iron and steel	152	0.65	217	0.73
Fabrication of metal products	8,401	0.85	9,218	0.86
Machinery and equipment	4,398	0.86	3,645	0.83
Electrical	365	0.63	583	0.74
Transportation equipment	121	0.44	558	0.78
Region of manufacturing industry				
East Sweden	12,701	0.90		
Southeast Sweden	12,436	0.89		
South Sweden	4,383	0.82		
West Sweden	8,045	0.84		
Central Sweden	4,470	0.83		
North Sweden	2,408	0.82		

Estimation alternative I

Let z denote the observed employment cumulative share variable. Observations where $\hat{z} \geq 0.9999$ were eliminated. A weighted least-squares approach was used to minimize $\Sigma[h(\hat{z}-\bar{z})]^2$, where $h=\hat{z}$ for $\hat{z}<0.5$ and $h=1-\hat{z}$ for $\hat{z} \geq 0.5$.

Estimation alternative II

This alternative utilizes unweighted least squares with elimination of $\hat{z} \geq 0.9999$ and $\mu \geq 300$.

Appendix 2: Conversation Menu

The implementation of the data base, dialogue access, and graphic presentation of results has been made in the programming language APL for both the SIND-data and the SUPPORT information systems.

The dialogue is especially designed for asynchronous terminals using low-speed dial-up connections. The design is intended to minimize the number of characters transmitted between the terminal and the computer. Data base access is achieved via a dialogue session that can encompass several passes through the questioning system.

During each pass a lot of table forms, predefined charts, or data variables for user-specified analysis can be requested. All tables or charts are collected at the end of the session and saved. They are later retrieved in a presentation session, which will not be dealt with further here.

The dialogue is menu-oriented and is easy for the inexperienced user. The expert, on the other hand, can run through a session very fast. At any point in a dialogue pass he can suppress a number of question texts by typing the corresponding answers at once, separated by a certain delimiter. Questions on branch, region, and time allow for several alternative answers. A pass through the dialogue results in all combinations of the alternatives chosen, thereby reducing the typing effort considerably.

Abbreviations can be made in the response alternatives, which lessens the typing work further. If the user's shortened answer results in an ambiguity, then the system only presents the alternatives matching the response and asks for one of them. Single alternatives can consist of several words separated by blanks. Abbreviations are also allowed within single words. If the user responds with an "empty" answer, the dialogue pass is canceled and a new one is started. The earlier passes are not affected, however. An empty response to the first question in a dialogue pass will end the session.

The presentation of the data accessed in this way can be made flexible. For instance, it is possible to choose between observed and estimated data. Text can be shown in different languages, and plotting done on different media.

An excerpt from a dialogue is shown below, where the computer writes in uppercase letters and the user writes in lowercase.

```
.
.
.
SPECIFY REGION:  any
ANY:  PLEASE CHOOSE BETWEEN:

EAST SWEDEN       CENTRAL SWEDEN
NORTH SWEDEN      SOUTH EAST SWEDEN
SOUTH SWEDEN      WEST SWEDEN

SPECIFY REGION:  s
```

s: PLEASE CHOOSE BETWEEN:
SOUTH EAST SWEDEN SOUTH SWEDEN

SPECIFY REGION: s e
(Southeast Sweden is picked out.)

A more advanced example is demonstrated below.

.
.
.

SPECIFY REGION: e, s_w
(First, e picks East Sweden. Then, s_w was intended to pick out some South part of Sweden and proceed to West Sweden.)

S: PLEASE CHOOSE BETWEEN:
SOUTH EAST SWEDEN SOUTH SWEDEN

SPECIFY REGION: s s
(This refers *only* to the ambiguous part. East, South, and West Sweden are picked out as a correct response to the first question.)

References

Johansson, B. (1983) A structural change model for regional allocation of investments. *Working Paper* WP-83-29, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Johansson, B., and I. Holmberg (1982) A regional study of the distribution of vintages and profits of industrial establishments: A stochastic transition model. *Regional Development Modeling: Theory and Practice*, eds. M. Albegov *et al.* (Amsterdam: North-Holland), pp.215–227.

Johansson, B., and U. Strömqvist (1981) Rigidities in the process of structural economic change. *Regional Science and Urban Economics* 11:336–375.

Kullback, S. (1959) *Information Theory and Statistics* (New York, NY: Wiley).

Marschak, J. (1974) *Economic Information, Decision and Prediction, Selected Essays* vol.2 (Dordrecht: Reidel).

Nijkamp, P. (1982) Spatial information systems – A research strategy. *Collaborative Paper* CP-82-35, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Persson, H., and B. Johansson (1982) A dynamic multisector model with endogenous formation of capacities and equilibrium prices: An application to the Swedish economy. *Professional Paper* PP-82-9, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Strömqvist, U. (1983a) *Lönsamhetsstruktur och Investeringsmönster* (Profit Structure and Investment Pattern). *SIND Report* 1983:1, Statens Industriverk (Stockholm: Liber).

Strömqvist, U. (1983b) An economic analysis of agriculture and industry in the Skåne region. *Collaborative Paper* CP-83-15, International Institute for Applied Systems Analysis, Laxenburg, Austria.

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CHAPTER 15

Disaggregate Spatial Information Systems: The Use of Geocoding in Regional Planning

Jan van Est and **Frans de Vroege**

1. Introduction

The complex structure of a regional system and the lack of understanding of regional development processes make it very difficult, if not impossible, to guide and to regulate these processes effectively. To reduce this uncertainty in planning and decision making, information systems for regional planning are designed and used as decision support systems (Hinloopen and Nijkamp 1982). This approach relies on the availability of relevant data and proper information so that it is possible to monitor development processes and prepare (alternative) plans. However, to supply the necessary information very often requires impractically large amounts of time and money. The resulting gap between required and available information influences decision making, in that some decisions are either postponed or are made without an adequate rational foundation. To overcome this problem, methods should be developed to supply information in due time and at reasonable cost, since information is the driving force behind planning.

A basic aspect of data processing and information supply for regional planning is the locational referencing of data elements and statistics. A house is known by its address and a property by its parcel number, and the number of unemployed people is assigned to a particular area or zone. This locational reference appears to be the most important difference between spatially oriented information systems and systems for other kinds of planning and decision making. Nevertheless, until the late seventies locational referencing did not receive as much attention as it should have. Indeed, it still hampers the proper and systematic supply of information.

Locational referencing alludes to the spatial dimension of an information system for spatial planning. It has two specific functions:

(a) to identify data elements individually, e.g. the address of a house; and
(b) to identify data elements spatially and to process data to derive the required information, e.g. aggregation and assignment of individual houses to the number of classified houses in particular, arbitrary regional zoning systems.

The second function is found in almost no information systems for regional planning. In other words, aggregation of data for particular zoning systems and thematic mapping have to be carried out manually. It follows that instead of functional zoning systems only administrative subdivisions are used, and that handmade thematic maps are only used incidentally. The burden of disaggregated data collection and data processing is so great that either the information is supplied too late or it is not produced at all. It follows also that most people are working on an *ad hoc* basis without any overall coordination.

Many data files have been created for either similar or overlapping zoning systems, producing different figures. Differences in orientation with respect to spatial scale and aggregation level prevent data from being used by other than the primary users for their original purposes. To make regional information systems more versatile, the spatial dimension must be incorporated. The way to do this is explored in this chapter. Section 2 presents an outline of a spatially oriented information system, concentrating on the geographic base file and the specific meaning of segments for such a system. In Section 3, we shall show how coordination between planning agencies, both horizontally and vertically, and between spatial scale levels can be achieved.

2. Segments and a Spatially Oriented Information System

2.1. *The Information System*

In the 1960s and early seventies many data files were computerized and many integrated mathematical models were constructed to fulfill the promise that high-speed computers with large storage capacities could quickly provide comprehensive information for regional planning, including estimates of the consequences and efficiencies of alternative plans. These promises were frustrated (Rautenstrauch and Pannitschka 1980), the building of computerized information systems usually going no further than collecting data and making data banks. Modeling and other scientific methods were not introduced into computerized planning practice.

Information (systems) and data (files) are very often used as synonyms, but this is to misunderstand both concepts. A data file is nothing more than an ordered set of attributes of several items, which forms the basic material from which information is extracted. An information system is much more than a set of data files; it consists of people and procedures, as well as computer hardware and software (US Department of

Housing and Urban Development 1968). This definition of an information system is very broad. In this chapter, discussion is limited to the way in which data are processed.

An information system can be considered as a tool to store and link several data files, to retrieve and transform data for use in statistical and mathematical modeling (i.e. data analysis), and to translate the results into information for planners and politicians. This definition (Scheurwater and Masser 1981) is illustrated in Figure 1 and fits very well the three key activities in the planning process: description, analysis, and evaluation (Nijkamp 1982).

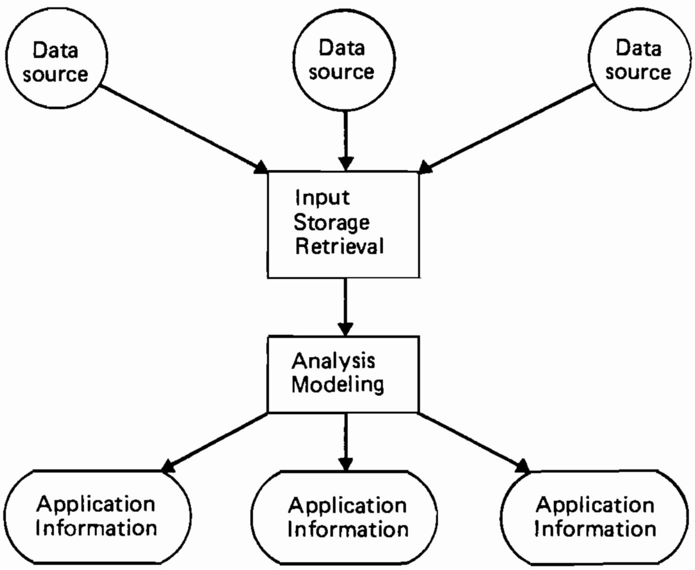

Figure 1 The information system.

From the methodological point of view, to incorporate a model into an information system is not of major concern; a proper information system should be able to handle various kinds of statistical and other modeling operations. Attention should be focused instead on the other phases of data processing. Of importance are the way data files have to be designed and processed to produce suitable model input and the way model results have to be translated into clearly understandable tables and thematic maps for use by planners and politicians, since they strongly determine the structure of an information system for regional planning.

For the planners, reading statistical data from a map has clear advantages over having the same information listed in tables. For example, a map can highlight problems at a glance. For many governmental agencies, however, producing thematic maps by hand turned out to be too great a problem. After alternative approaches were examined, it was concluded that a spatially oriented information system based on a segmented geographic base file was required.

2.2. *The Segment Method*

Regional planning means, among other things, preparing and evaluating alternative plans. These plans can range from the local scale to the regional and national scales. In all cases, there is a very close relationship between the data and the map on which they are displayed. Since it is their simultaneous use that makes up the information system, the map should also be computerized, not like large-scale maps (1: < 2,500) but in a more schematized way. By digitizing information on the intersections of the transport infrastructure (roads, waterways, railways, etc.) one can define a network of nodes and road centerlines, i.e. segments. Segments are identified by their node numbers or segment number; they can describe both sides of a street separately, with a street name and ranges of house numbers. Also, frequently used area codes for administrative zoning systems, such as census tracts, can be added. This idea of encoding an infrastructure network completely is known as the DIME concept (dual independent mapping encoding) (US Bureau of the Census 1970). The resulting segment file is known as a geographic base file (GBF).

The encoding of segments therefore makes it possible to incorporate a map into a computerized information system. Segments are used for the following functions:

(1) to locate addresses along segment sides to acquire a general idea of the distributions of data elements, e.g. shops and business sites;
(2) to locate "semiaddresses" along segment sides, e.g. car parks and road accidents, so that registers that include locational references of such items can be constructed and used in an information system;
(3) to link individual data elements for various purposes: (a) to aggregate data into predefined and arbitrary zonal subdivisions (when the boundaries of the zones are known and described by segments, the inner segments can assign individual data to the zones); or (b) to establish spatial relationships between individual data elements (e.g. public facilities) according to predetermined shortest paths in the network; or (c) to determine an area subdivision for a special application by assigning characteristics to segments that will be combined by criteria of homogeneity;
(4) to determine the shortest paths in a network, measured in length, time, or cost, to build impedance or distance matrices;
(5) to calculate spatial statistics and other characteristics of regional phenomena;

(6) to draw thematic maps automatically, using coordinate referencing of vertices or nodes of segments and of locations of particular thematic subjects.

These functions can be grouped into two classes. The first two functions refer to the spatial identification of the *information sources*, i.e. the spatial registering and visualizing of elements of data files, while the other four functions refer to the processing of these elements, where segments are used as *information carriers*. From the definition of a segment it follows that spatially oriented elements, as point locational references, are linked to the segments. Together they represent the idea of a spatially oriented information system as a spider's web. This "cobweb theorem" is illustrated in Figure 2.

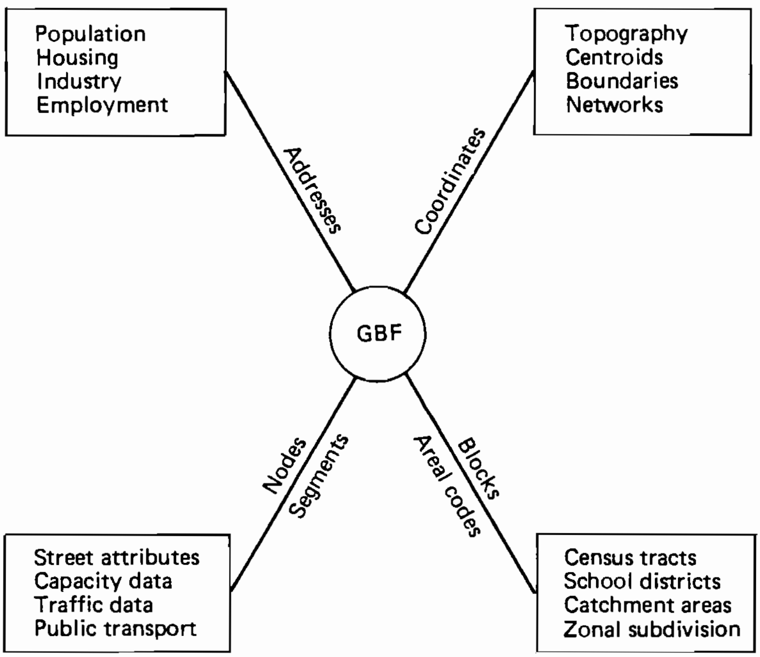

Figure 2 Cobweb theorem of spatially oriented information systems. GBF: geographic base file.

Data elements can be linked to the segment file by four different locational references (van Est and de Vroege 1982a): addresses, nodes and segments, coordinates, and areas or zones. From Figure 2 it can be seen that the GBF is the center point, the pivot that "spins webs" for capturing data files. It can thus be seen that the simultaneous coordination of information sources (data files) and information carriers (segments) constitutes a base for a spatially oriented information system (van Est and de Vroege

1982b). A GBF and computerized data files must be available for such an information system to be created.

The cobweb theorem has several organizational implications. The GBF forms the central part and should therefore be kept centralized. For a town government it means that a particular central agency should be charged with the maintenance and updating of the geographic base file. The data files, on the contrary, should be kept by those offices or agencies that are responsible for their creation. This implies a decentralized form of organization with a maximum of flexibility. It also emphasizes the responsibility of each office in working with computerized data. The application of the segment method provides a firm basis for an efficient way of data processing and information supply as well as for a flexible framework to organize a spatially oriented information system. It is the decentralized aspect of the organizational form that solves the problem of the size of the information system and guarantees its efficiency.

3. Spatial Scaling and Spatial Referencing

The principles of spatial referencing and data processing outlined in the previous section imply that it should be feasible to coordinate data transfer between and information supply to various governmental agencies operating on different institutional levels and in different sectors, as well as to bridge different spatial scales. However, a spatially oriented information system cannot solve the classification problem, which can hamper communication. It happens very often that different definitions are used. For example, in the Netherlands the Central Bureau of Statistics and the Post Office define a residential unit in quite different ways. The appropriateness of a definition depends on the problem to be solved. The information system can stimulate uniform classification because it provides a better and more efficient use of existing data.

A physical object can be identified with its locational reference, which can vary from the microscale to the macroscale level. The micro level is the smallest unit with which an object or event, e.g. a house, a traffic accident, or a cadastral parcel, is associated. In general, two kinds of basic spatial unit can be distinguished: address and semiaddress units. Most local data files are based on address references, such as housing and population files. Many other spatially located objects and events, such as car parks and traffic accidents, can be associated with a semiaddress reference (van Est and de Vroege 1982a). For other elements, more arbitrary decisions have to be taken. In this respect, the cadastral parcels are the most well known nonaddress-based locational references.

All these basic spatial units can be considered as point locations and can be linked to segments (van Est and Smit 1980). This integration of points and segments makes the information system flexible, because it can now aggregate data to any desired spatial scale or zonal division by combining sides of segments. The problem in daily practice, however, is either that disaggregated data files are not available or that aggregated or zonal figures are known only for particular administrative zoning systems. Therefore, it happens very often that:

(1) various data sources are available for different and overlapping zoning systems, but cannot be linked to each other;
(2) one item is distributed over various zoning systems in one region, which then show significantly different overall figures;
(3) zonal statistics, based on administrative zoning systems, cannot be redefined for functional zoning systems.

These three problems arise very often with population and employment data. The solution depends on the kind of aggregated data, of which there are basically two groups:

(a) statistics, based on sampling, e.g. the national labor force sampling survey and the housing needs sampling survey;
(b) zonal figures, which are based on enumeration from disaggregated data files, e.g. population and migration figures.

The segment method can be used to determine zonal figures by enumeration of individual elements along each side of a segment. The method is fairly flexible and efficient, and the enumeration can be done automatically for each arbitrary zoning system. For illustration, we shall describe the assignment of a housing file to a particular zoning system. Let us assume a zonal division into 50 zones and a file containing 100,000 residential units. The boundaries of the zoning system can be described with 500 segment sides. When the boundary segments are given as input, the computer program can find all inner segments of each zone and the assignment of residential units can now be executed using these segments. Instead of 100,000 manual assignment actions, one uses 500 manual boundary descriptions and a computer run. An advantage of the latter method is that the results can be shown on thematic maps automatically. This saves weeks of labor and, on average, reduces the cost to 10%.

Sampling surveys are very often drawn on particular zoning systems for a single purpose. Consequently the statistics usually cannot be used for other zoning systems. To overcome this lack of versatility, expansion factors should be used on subareas that are as small as possible. That is, sampling should be based on individual segments or a small group of segments. The size of sample subpopulations can then be determined by enumeration of segments, while samples can be drawn at random according to known characteristics of the subpopulations concerned.

The segment method, as described above, is versatile and provides a basis for multipurpose enumeration and sampling. Also, if one is dealing with data on a particular zonal scale and new questions arise, one is able to go back to disaggregated data sources and answer the questions on the appropriate level, and the results can be aggregated to the original zonal level. An example of such a question is an internal migration problem. Overall zonal figures are known, but the required information on households and housing characteristics, for instance, is too detailed for records to be kept on a district zoning system. However, the availability and accessibility of disaggregated data sources are essential if one is to be able to answer such questions, and a spatially oriented information system, in the form of the segment method, provides the proper framework. This conclusion reflects a nuance in opinion compared with that of Peters in Chapter 3. A spatially oriented information system can be flexible but this does not mean that most disaggregated data are stored centrally. The principles of the cobweb theorem suggest the contrary: disaggregated data are available and stored in *decentralized* organizations so that they cannot overload the information system. If the segment framework is pursued, decentralized data files should be not only available but also accessible.

In summary, spatial references can vary from the microscale to the macroscale level. The segment method provides consistent and uniform data-processing procedures along the "micro–macro data line," and in fact creates a "common spatially oriented language" (COSOL) for information exchange and coordination (vertically and horizontally) between governmental agencies (van Est and Smit 1980). Through COSOL, data, though assigned to different spatial levels, can be related to each other by proper aggregation or disaggregation methods. Only data files, created according to the COSOL concept, can provide the information system with the necessary versatility.

4. The Two-Pyramid System

The previous section outlined how data processing along the micro–macro data line enables basic spatial units, as point locations, to be assigned to more aggregated or greater zonal levels. There is, however, no need to consider basic spatial units only as point locations; they can also be looked upon as polygons, since they have surface area. It is possible to describe the polygon boundaries with segments. At this point, new segments have to be introduced because these boundaries are different from the infrastructural network of segments.

Starting from a point location at the micro level, one can follow two different ways to achieve an areal description. The first is to consider the individual element on an aggregated or zonal level and the second is to consider the element with its own areal surface. Both results can be seen as macro or zonal levels, though different from each other. For both methods the COSOL concept and the segment method can be applied.

The resulting two micro–macro data lines, though of different kinds, can be combined into one locational referencing system: the two-pyramid system, illustrated in Figure 3. All data-processing activities are channeled to and from the micro level. The aggregation procedures and data analysis, as normally used in urban and regional planning, refer to the upper pyramid (the bottom-up approach). In geodesy and land information one deals with the lower pyramid (the top-down approach). The micro level remains the pivot of the system. Although in both pyramids the same segment methods are used, the segments themselves are of different natures. While the upper pyramid describes the infrastructural network, or communication channels, the lower one describes the outer boundaries of basic spatial units and the objects within. The introduction of the segment method in planning practice has brought together different disciplines and themes, which, in spite of their differences, complement and benefit each other.

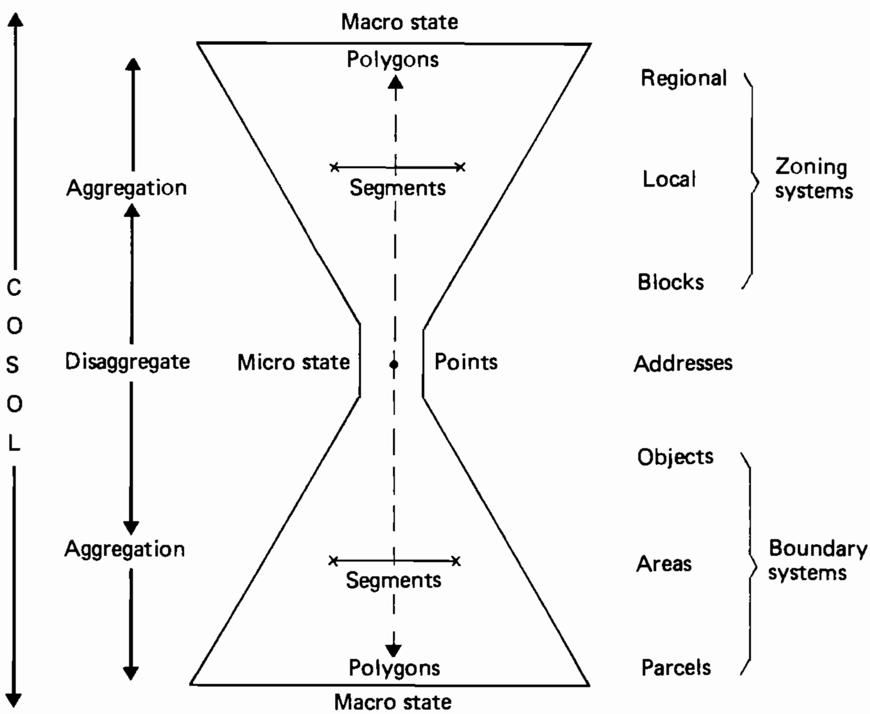

Figure 3 The two-pyramid system.

5. Conclusion

Peters concluded, in Chapter 3, that spatial information systems are much more complicated to handle than nonspatial systems. The truth of this statement is proven in practice by the huge amounts of time and money involved in processing spatially oriented data and producing thematic maps. He also stated that information exchange is not only a technical problem but also a political problem of power distribution. Information "supersystems" are not the answer. There is a great resistance to them because they are difficult to control and cannot be operated economically.

From a technical point of view the segment method can alleviate many problems. It provides the framework of a decentralized organizational form for a spatially oriented information system in which every agency may keep and maintain its own data files. The cobweb theorem of spatial referencing epitomizes an efficient way of data processing and analysis and thematic mapping. The COSOL concept is an incentive for a common information base and a step toward consistency and better coordination of information exchange. The two-pyramid system shows, finally, how various spatial levels and disciplines are related to each other and how coordination can be achieved between them.

The use of a spatially oriented information system does not guarantee a better rationalization of the planning process itself, but it does ensure a better, quicker, and more efficient way of information exchange. Such an information system can be considered as a decision support system, though it is not a substitute for the decision process (Voogd 1983; see also Chapter 6 by Hinloopen and Nijkamp). It is not tailored to simulate activities and to support negotiations. It is a very efficient tool for helping to visualize the planning problem and to deliver information on alternative decisions and plans.

References

van Est, J.P., and L. Smit (1980) Geocoding: The spatial dimension of an information system. *Report*, Research Center for Physical Planning, TNO, Delft.

van Est, J.P., and F. de Vroege (1982a) The meaning and construction of a geographic base file for a spatially oriented information system. *Paper* presented at 9th European Symposium on Urban Data Management, Valencia.

van Est, J.P., and F. de Vroege (1982b) The data source and information carrier as a base for a spatially oriented information system. *Working Paper* 25, Research Center for Physical Planning, TNO, Delft (also published in *Bremer Beiträge zur Geographie und Raumplanung*).

Hinloopen, E., and P. Nijkamp (1982) Information systems in an uncertain planning environment – Some methods. *Working Paper* WP-82-117, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Nijkamp, P. (1982) Information systems for multiregional planning. *Collaborative Paper* CP-82-27, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Rautenstrauch, L., and W. Pannitschka (1980) The information and planning systems (IPS) of the Umlandverband Frankfurt: An information system for physical planning under conditions of a changing planning philosophy. *Paper* presented at Third International Workshop on Regional Science Methods in Urban and Regional Planning, Dortmund.

Scheurwater, J., and I. Masser (1981) Monitoring spatial planning in the Netherlands: An outline of an information analysis system. *Strategic Planning in a*

Dynamic Society, ed. H. Voogd (Delft: Delftsche Uitgeversmaatschappij), pp. 193–204.

US Bureau of the Census (1970) Census use study: The DIME geocoding system. *Report* 4, Washington, DC.

US Department of Housing and Urban Development (1968) Urban and regional information systems: Support for planning in metropolitan areas. *Report*, Washington, DC.

Voogd, H. (1983) Decision support systems for governmental planning. *Paper* presented at Workshop for Multicriteria Analysis, University of Technology, Delft.

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CHAPTER 16

Technical Aspects of Computerized Spatial Information Systems

Aribert B. Peters

1. Introduction

Until very recently the task of the computer was to perform specified arithmetic operations on a given set of data and to print or plot the results, but the capabilities of computers have changed. Today, the preparation of a plan might involve the computer in nearly every step, and therefore also the job of the planner is changing (Lewis 1982). Instead of the user putting in the data and deciding the sequence of operations, the data are nowadays collected in the computer or different computers, and standard-package operations are performed. In this way the user rarely comes into contact with the data or with the basic arithmetic. Instead, knowledge of the computer hardware and software components, of the data structure, and of the way in which data are stored is retrieved as required. The plan will be prepared by the plotter of the computer, the text by a text-processing system. The bill for the plan will be written by the computer and the payment will be transferred via computers.

Essentially, the computer performs several different tasks in a spatial information system:

(a) storage update and retrieval of data;
(b) running programs for the analysis of data (models);
(c) preparation of output in the form of texts, diagrams, or maps;
(d) communication with the user about the way in which these tasks are to be performed.

The microcomputer revolution has changed the general attitude toward computers, causing a rapid increase in their use for different tasks in the planning process. Consequently, integrated planning information systems will be used more frequently and will improve in quality.

Moreover, improved hardware and software technologies will upgrade the quality of information systems. Human factors will obtain greater relevance, so that the use of computers and the development of programs will be easier (Ramsey *et al.* 1978). Of special interest here is communication between man and machine, i.e. the computer language.

The state of the art of hardware and software fifteen years ago was such that punched tapes were the major communication medium with the machine. Arithmetic operations were performed by machines that were of the size and price of typewriters. The technical standards of today are not older than five to seven years. Successful development relies on mutual iterative adaptation of technical concepts and user expectations and requirements. Only two or three such iterations have been possible in the short development period of computer technology.

The major computer developments during the last five years have been:

(a) a general breakthrough in interactive modes of communication via terminals;
(b) increases in speed and storage capacity, together with a decrease in prices that made the new technologies generally available;
(c) an increase in the capacity of mini- and microcomputers as a result of miniaturization in electronics;
(d) an increase in telecommunication between computers.

These developments have not been incremental but are significant qualitative jumps.

2. Data Structures

The data management system is of more importance for spatial than for nonspatial information systems. Very often data are retrieved via their spatial location and therefore space is a key variable. As will be explained below, this causes problems. The second awkward property of space is that the amount of data in the data base increases by multiples of the number of spatial units considered. In most cases these increases are two, three, or four orders of magnitude and call for more efficient techniques of data storage, searching, and organization. It might be acceptable to double the time needed for data retrieval, but it is impossible to wait one thousand times longer. These are the basic reasons why professional data base structures are needed for spatial information systems.

Productivity depends on the way in which the data are stored and on the user's view of the data base – the data model. The physical storage structure need not be the same as the user's view of the data. This distinction between storage structure and data model is especially useful when the relational data model is introduced. Currently three different kinds of data model are generally distinguished (Date 1975, p.41): (a) hierarchical, (b) network, and (c) relational.

The hierarchical approach is very popular. In this type of model, data are stored in a tree-like structure. There is only a minimal distinction between data model and storage structure. A prominent example is IBM's Information Management System (IMS) or the Scientific Information Retrieval System (SIR). Problems and diseconomies occur if different perpendicular access trees are needed, which is very probable if spatial data are stored. Space would be the main structural criterion, but equivalent, simple accesses via other subjects are desirable.

The network approach, proposed by the Data Base Task Group of CODASYL, overcomes the difficulties of the hierarchical approach but keeps very close to the actual storage structure. The user has to be thoroughly aware of which chains do and do not exist, and his programming rapidly becomes extremely complex.

The relational approach separates data model and storage structure and simplifies the data model as much as possible. A clear distinction between the logical and physical aspects of data base management is introduced, thereby encouraging a common understanding of the data by users and programmers alike. The basic idea is very easy to understand. A multidimensional relationship can be illustrated by a two-dimensional relation: instead of writing matrix A as

	b_1	b_2
c_1	1	10
c_2	15	20

one can express A as a relation $A(B,C)$:

B	C	A
b_1	c_1	1
b_1	c_2	15
b_2	c_1	10
b_2	c_2	20

If more than two dimensions are involved, the matrix has to be written as a relation to show all elements.

The relational approach is a logical (user) view of data organized as two-dimensional tables. It closely follows the traditional representation of sequential files, with rows corresponding to records of the file and columns corresponding to fields of records. Such tables are known as relations and are a rigidly defined construction of mathematics. Relations are highly organized files since:

(1) each file contains only one type of record;
(2) each type of record has a fixed number of fields;
(3) each record occurs only once;
(4) the position of each record has a unique identifier (key);
(5) record locations either have an unknown order or are ordered according to values contained within those locations;
(6) associations between records are represented solely by data values in the fields (Date 1975).

Tables are the most important representation of relations, because they are universally understood (Codd 1982, p.111). A certain number of columns constitute the key of the table (the values of B and C in the example). Such addressing of data by value rather than by position boosts the productivity of programmers as well as users.

The manipulative part of the relational model consists of the algebraic operators (select, project, join, etc.), which transform relations (and hence tables). Relational processing entails treating whole relations as operands (set processing capability) (Date (1981) describes integrity rules for relational processing).

The ease of use of different data base systems has been tested experimentally, and relational systems seem to show a definite advantage (Lochovsky and Tsichritzis 1977, Reisner 1981). A lot of different relational data base systems are already available (Kim 1979). For example, in Ann Arbor, Michigan, a special-purpose urban information system has been successfully installed (Bohl 1978). An advantage of relational operators is the "cut and paste" way in which the table containing the desired information is formed. Bohl concludes: "The relational approach provides the ultimate in ease of use and flexibility while maintaining the ability to meet the diverse and unanticipated information needs of local government."

A lot of big projects to establish integrated information systems never become fully operational because the data structure is too complicated for users and programmers. The relational approach is a promising new development, because the critical part of existing systems was conceived correctly: the communication between user and machine.

3. Communication Problems

The user of a computerized information system and the program in the machine communicate in the language constructed by the designer of the system. The crucial question is how easily the planner's idea about the necessary information processing can be transferred to the computer. Because a major task in the planning process is to find out in which way data are most appropriately compiled, the construction of the planning language is in itself a planning process.

This argues in favor of taking into account the experience and knowledge of the planners in designing the language, which is a condensed image of the model. The programs do no more or less than realize this language; they are a function of it.

If a user is ignorant about the capabilities or details of the language he has to be taught by the program itself, the manual, or some expert. The standard means of communication are the keyword technique, the menu technique, help commands, and prompting sequences. The careful design of manuals and teaching procedures deserves much more attention in the future.

The efficient use of the system depends critically on the ease of information exchange between user and machine during the phase of task specification. Not every error in this phase is caused by the user's ignorance. Because nowadays the user is the more intelligent, he is supposed to learn from the program, but in a couple of years this asymmetry may be broken and the learning computer will accept human fallibility and adapt to the user.

Today, elaborate expert systems or knowledge-based systems are capable of bringing specialized knowledge to bear on fuzzy, nonnumerical problems that hitherto resisted solution by computer. Examples of such systems are computers that can program themselves, translating plain English into statements of a program language. Other systems were developed for medical diagnosis and oil exploration. However, the high development costs of these systems limit their general availability (Alexander 1982a,b,c).

A related development is natural-language programs that can comprehend and obey in everyday English. Programs that rely mainly on syntactic analysis for limited understanding of ordinary English are becoming a commercial success. The leading example is INTELLECT, developed by Artificial Intelligence Corp. of Waltham, Massachusetts, which can be attached to large data bases, enabling untrained users to retrieve information with queries in more or less everyday English (Alexander 1982a,b,c).

The number of planning languages is nearly as large as the number of available program packages. Each language relates to a specific class of tasks. It is hardly possible to speak about planning languages in general because planning is so diverse a field. Even the restriction to regional planning covers a variety of planning purposes (demographic, economic, environmental, etc.) and of planning traditions. The complexity of spatial planning languages results from the complex structure of spatial data, spatial models, and of graphic or cartographic output (Baxter 1976). A certain degree of standardization (similar to FORTRAN) is desirable.

Apart from the user–machine communication problem there is another between the user and his client, i.e. the public or the decision maker. Because of the complexity of the spatial dimension this problem is more severe in spatial planning.

4. Spatial Referencing

The inclusion of the spatial positions of thematic elements not only multiplies the amount of data and the complexity of storage and retrieval functions in regional information systems, but it might also change the basic types of analysis performed with the data and require special output procedures. Spatial information systems can use prepared general-purpose software only to a limited degree. Consequently software development is a prerequisite for most spatial analyses. The amount of individual development varies with the spatial scale and with the importance of space in the analysis. For a simple regression over all spatial units in the system a standard package can be used. As soon as spatial autocorrelation is introduced, extra programming is needed.

Space is not an additional variable, but it changes or more or less determines the relationships between all the variables considered. The crucial importance of this dimension and its incomparability with other variables are the fundamental cause of the difficulty of creating spatial information systems. Minor changes to existing packages will not adapt them to spatial problems. This is the reason for the "spacelessness" of most statistical spatial analyses.

At the scale of small areas, of towns or villages, topology has crucial importance and information about segments, nodes, and links gains in relevance. Special packages have been developed for the management and analysis of geographic data, such as the ODYSSEY package of the Harvard Laboratory for Computer Graphics and Spatial Analysis (Teichholz 1978).

5. Cartographic Output

The natural result of geographic analysis is a map – probably thought of as a compensation for difficult programming work. On the other hand, computers are being increasingly used for cartographic purposes. The listing of existing cartographic packages is in itself a book of two volumes, which proves the popularity of computer cartography (Oest and Knobloch 1974, 1976). A lot of techniques of computer-aided design migrated successfully to cartography. As in geocoding, no major system has become a general standard. The reasons might be the same in both cases: it is often much easier to solve the problem at hand than to install a general-purpose package. This might change soon, as the hardware and software components become more standardized with bigger sales. The need for the exchange of information, programs, and experiences is thus increasing.

New software technologies will facilitate the use and exchange of cartographic packages. Computer cartography will also benefit from progress in theoretical cartography, which investigates the relationships between maps and their users. Technical knowledge about computers is only one ingredient for the production of cartographic output. At the same time knowledge of cartography and of planning methodology is also required.

6. Outlook and Conclusions

The breakthrough of computerized spatial information systems was delayed by, among other things, hardware and software bottlenecks in computer technology. Enlarged storage capacities and improved software technology for large data banks will broaden the information base of spatial information systems. Also, administrative data bases will probably be exploited more easily for planning purposes. The use of computers for everyday tasks will change common attitudes toward computers very quickly and the capabilities of computers will become familiar to everybody. Also, communication between man and machine will be further facilitated by adaptive, intelligent computer systems. Even if the use and relevance of spatial planning remain unchanged in the future, improved computer technologies will increase significantly the quality of every facet of spatial information systems.

References

Alexander, T. (1982a) Teaching computers the art of reason. *Fortune* 17 May, pp.82–92.

Alexander, T. (1982b) Practical uses for "useless" science. *Fortune* 31 May, pp.138–145.

Alexander, T. (1982c) Computers on the road to self-improvement. *Fortune* 14 June, pp.148–160.

Baxter, R.S. (1976) *Computer and Statistical Techniques for Planners* (London: Methuen).

Bohl, F.L. (1978) A relational approach to an urban data base. *Data Resources and Requirements: Federal and Local Perspectives* vol.1 (Chicago, IL: Urban and Regional Information Systems Association), pp. 228–237.

Codd, E.F. (1982) Relational data base: A practical foundation for productivity. *ACM Communications* 25: 109–117.

Date, C.J. (1975) *An Introduction to Database Systems* (Reading, MA: Addison-Wesley).

Date, C.J. (1981) Referential integrity. *Proceedings* of Conference on Very Large Data Bases, Cannes, 9–11 September, pp.1–12.

Kim, W. (1979) Relational database systems. *Computing Surveys* 11: 185–211.

Lewis, S. (1982) The modern planning office. *Planning* September, pp.12–20.

Lochovsky, F.H., and D.C. Tsichritzis (1977) User performance considerations in DBMS selection. *Proceedings* of ACM SIGMOD Conference, pp.128–134.

Oest, K., and P. Knobloch (1974, 1976) *Untersuchungen zu Arbeiten aus der Thematischen Kartographie mit Hilfe der EDV* (Hanover: Schroedel-Verlag), vol.1 (1974), vol.2 (1976).

Ramsey, H.R., M.E. Atwood, and P.J. Kirshbaum (1978) *A Critically Annotated Bibliography of the Literature of Human Factors of Computer Systems* (Englewood, CO: Science Applications).

Reisner, P. (1981) Human factors studies of database query languages: A survey and assessment. *Computing Surveys* 13: 13–31.

Teichholz, E. (1978) Overview of the ODYSSEY geographic information system. *Data Resources and Requirements: Federal and Local Perspectives* vol.1 (Chicago, IL: Urban and Regional Information Systems Association), pp. 164–177.

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CHAPTER 17

Information Technology and Integrated Regional Development

M.R. Wigan

1. Introduction

Information systems for integrated regional development have become subject to the rapid convergence of technologies epitomized by the phrase "information technology." This chapter places some of the recent and emergent tools of information technology in context with the patterns of information management and production developed by regional planners. These developments fall into several categories:

(1) The range of opportunities to process and draw from data assemblies has increased by several orders of magnitude.
(2) The need to integrate data collections of national statistical bodies with monitoring statistics has become a matter of urgent concern.
(3) Communication and data capture techniques have undergone (and will continue to undergo) fundamental changes that will affect both the execution of regional planning and development and the management of the process.
(4) The public has, simultaneously, increasing expectations of both more efficient developmental planning and greater restraints on the access to and security of information on individuals.

Treatment of the developments will follow the same general path as these descriptions. First to be treated will be the tools of the trade, in the currently conventional sense, followed by some implications of data networks and knowledge-based systems. Next, the needs for raw data input, its timeliness, and its nature will be considered, in conjunction with the balance between data reduction and presentation and the need to synthesize such complex and extensive material into problem-specific form:

albeit with or without a specific regional, econometric, or other forecasting framework.

Thirdly, the impacts of the recent expansion of networked communications on the nature of both regional development and regional development planning and management will be explored. Lastly, the potential and actual problems of public demands for security of data held in public-authority and other data banks, and the increasing need to hold down the costs of information collection will be discussed.

2. Tools of the Trade of Information Technology

The traditional tools for regional analysis have been heavily influenced by input–output analysis, sectoral studies, and other tools broadly following the accounting matrix format. The problems of subregional (and subnational) input–output table production are well documented, and a wide variety of empirical and other devices for creating subregional tables have been tried. All rely, in the end, on data availability – and many have had to depend on the triennial or decennial intervals of national input–output table production. Certainly all have had to accept the considerable delays inherent in the collation, production, and public release of these macroeconomic statistics.

Regional models that include the dynamics of the housing, transport, employment, fertility, and economic activity components of the system have become increasingly frequent in the literature. Once again, these systems are demanding in both the quantity and the often novel nature of the time series data required.

The microscale aspects of regional information systems have developed swiftly from the early land-parcel inventories to highly complicated geocoded, spatially oriented data bases. The more complex of these systems integrate the classifications of land-use and physical planners with plot and dwelling details, with public utility access points, lighting positions, water and sewerage locations, rating values, and other location-specific variables. Such systems, Amsterdam being an example documented by van Est and Smit (1980), also expanded to cover road accidents, traffic flow, and other activity variables. These comprehensive systems now form a convergence between the macroeconomic and the spatially specific, microeconomic lines of work.

Local government authorities (of the fairly small scale of the West Sussex County Council in the United Kingdom and the Sydney City Council in Australia) initiated such systems because of a revealed need in a specific section of their area of responsibility: road inventory and land-use parcel control, respectively; and then the integration followed.

Larger bodies, like the Greater London Council, undertook the production of separate (and major) information data bases, such as the GLC's complete, detailed inventory of the regional road system in the late 1960s, but let the investment collapse by not updating and maintaining them.

As an illustration of the accumulating problems of integrating and updating accumulating data bases, the detailed land-use recording systems for London over the last decade or more were inconsistent between different London boroughs, but were also updated sufficiently often to remain in use, and of real value – for example, in the 1974–76 GLC Regional Freight Policy development. At the same time the GLC regional accident location data base was being set up and used, and two regional transportation surveys were being carried out, as well as at least one major housing and one recreational survey. Each of these information systems was a major consumer of updating resources and was spatially oriented on a different regional basis, but was only marginally integrated at that time.

This pattern of multiple and overlapping spatially oriented regional information systems is not uncommon. However, the integration of these systems has had to await the widespread understanding of large-scale data base techniques, and the development of organizational structures geared to such data access. This integration has taken place over nearly two decades, and the current round of integration now well under way demands that the statistical and analytic tools in use by professionals be available with a smooth interface to these data bases. As is usual, only when serious attempts are made to make full use of the putatively available data banks do the real requirements for such data sets and analytic systems integration emerge.

A typical example of the convergence of tools and interfaces, in yet another of the London information bases, is the SIR data base system for scientific information retrieval. This is used to control the transportation planning data bank. It covers all of the normal data base processes and also interfaces to SPSS (Statistical Package for the Social Sciences) with the same syntax philosophy. This convergence is now being taken the obvious next step, with microcomputers being viewed as "smart" terminals to such large-scale data base computer systems, and SPSS syntax for smaller-scale statistical analysis has already become a marketable microcomputer-based product.

The present round of enhancing the capability of integrated data bases and application systems is taking place with unprecedented speed. The digital packet switched networks (typified by EURONET within the European Communities) are rapidly transforming the patterns of data acquisition and access across the world. The convergence of telecommunications and computing technologies has at last become a market reality and is beginning to reach the general professional consciousness in many disciplines as various Viewdata systems come into public use.

The tools of this altered environment are:

(1) packet switched networks as common carriers;

(2) Videotex as a "simple" mass data base access protocol and physical terminal device;
(3) cabling of large areas of domestic housing with video-bandwidth linkages and response;
(4) remote data bases (with searching software) as a large-scale commercial market;
(5) local networks of large and small computers;
(6) small computer systems with vastly enhanced local processing power, and tens of megabytes of storage in local small systems at low cost;
(7) graphics and color graphics processors of very high resolution at mass-market prices;
(8) the first tools (fairly primitive but still practically usable and widely available) for building "expert systems" to aid data structuring and retrieval.

These developments have occurred at a far greater pace than previous rounds of innovation. Integrating these new types of products, developing and setting up management structures and modes of operation that make effective use of them, and consequent changes in service levels, reaction times, and consultation and management strategies for regional planning and development are going to last into the late 1980s, at least.

By that time the tools will have developed substantially in power, but the fundamental changes in philosophy, in data access and use, and in data collection and availability are already clear and unlikely to be augmented by further large changes before 1990. The infrastructures now committed to be in place (cellular radio, video-bandwidth cabling with response capacity, satellite routings, and direct reception) require about this period of time to become fully operative, and are being discounted in this discussion.

Social adaptation could well take place faster than professional adaptation. The weight of early and expensive centralized and centrally controlled statistical collection and planning systems has already built up expectations of power and control balances, which are now being destabilized by the swift devolution of the power to access, hold, present, and process information and by the escalating need for more information to be reduced to a decision-making framework and for quicker and more direct response based on the broadening scale of integrated responsibilities and information.

The early introduction of Videotex systems as a "home service" by British Telecom was a clear marketing error. The businesses that could really use the synchronous timing of access and updating that Videotex provides, such as travel agents, with their need for large amounts of rapidly updated information on time-sensitive commodities and to book confirmations at the same time, have long been heavy users of telephones. The airlines (in particular) have an essential interest in a single, continuously updated data base of seat and type availability. It is not surprising that the travel industry has taken to Videotex with enthusiasm.

The French alternative to creating access to a large market has been to install massive numbers of terminal devices in specific areas as a means of both cutting the cost and increasing the market. This is bearing some fruit already since, with the regionalization of French government, many regions are requesting such pilot *Télématique* installations for their own areas, thereby accelerating the penetration of data access to more people and places and increasing the ability to garner information economically.

The implications of this are crucial for regional and development planning: the public Videotex systems have quickly made direct-connect, autodial modems a cheap consumer product, and as the home computer market had become orders of magnitude greater in the UK than the present Videotex market the communications aspects of Videotex have been supported by very cheap modems in the UK Micronet 800 service recently launched by British Telecom. This move has, at a stroke, given the UK public direct access to the world communication networks, as the Gateway systems to Videotex are now rapidly becoming established as a new and easy way of extending simple user access to information providers' *own* computers and data banks.

The common problems of data communication rates, protocols, and modem frequencies are all handled by the packet switched network services of the various PTTs. The Bell 103 US standard modem frequencies are quite different from the European/Australian conventions of CCITT V21. Such essential conversion problems have proved to be time-consuming and annoying even to sophisticated users, but the happy synergy of the Videotex 1200/75 baud standard and the advent of PSS networks as common data carriers for both national and international communications have protected users from many of the real barriers to increased acceptance and usage.

The phenomenon of the late 1970s was not the commotion about common carrier rights on PTT lines, but rather the prompt and effective emergence of community bulletin boards on microcomputer systems, accessed via modems at 300 baud over ordinary telephone lines. History is now rapidly repeating itself, with networks of professionals looking to this technique to expand their own interchanges, the demands of the microbiologists in Australia being merely one of the more recent such initiatives. This market is now being pursued by purveyors of electronic mail services on the packet switched networks, led by Telenet and Tymnet, presently among the largest international common carriers of such services. The stimulus for this came from the users whose own systems were operative and who wished to communicate with others, especially after tasting the joys of text capture and processing on their own machines, and to capture and exchange data and programs with each other without the problems of finding an acceptable floppy-disc format or of bringing two machines into proximity for file transfers.

The mass-market equivalent of this type of service is usually thought to be Videotex, but an equally important delivery system is Telesoftware.

This technique uses standard television transmissions with additional digital information packed on to the carrier. The Teletext, Ceefax, and Oracle services in the UK are typical such systems, but are designed for the ordinary text-reading user (with pages on the weather, news, etc.). Selectivity is built into the command for a page, and as the information issued is a fixed block sent repeatedly (although the broadcasting authority may alter the contents between scans), obtaining a page is a slow process. However, this time is not subject to any communications charge, and it is hardly surprising that Teletext adaptors have been sold to many times more homes than has the Prestel Videotex service of British Telecom.

The use of this available bandwidth for downloading computer software is increasingly being adopted. The British Broadcasting Corporation is now on the point of making Telesoftware available, without extra charge, to the many BBC Micro users, through a Ceefax adaptor. The difference between the ordinary Ceefax service and the new Telesoftware service is that the full video bandwidth available out of normal transmission hours is to be utilized, instead of the small fraction available during TV transmission times. The obvious expansion of this market as cable TV and wideband satellite links begin to spread is clear, and the BBC has already indicated a practical interest.

The integration of Videotex and Telesoftware is remarkably promising, whatever the means of delivery. The Austrian Videotex experimental service now being operated and developed with the participation of the International Institute for Applied Systems Analysis (IIASA) in Laxenburg and the University of Graz uses British Telecom's Prestel technology, but allied to an "intelligent" Videotex terminal (the MUPID color computer), so that the full Telidon dense-graphics mode may be adopted as far as the user is concerned. The response time of the small-scale services (including games) currently available for downloading (automatically, and transparent to the MUPID user) is excellent, yet the response interaction with host computers on the Videotex network is maintained. In this special case the Telesoftware is sent down the Videotex modem link, but the principle is clearly identical.

This broad-based push toward communications has led to electronic mail services over public telephone lines, and provided – and continues to provide – an efficient and much used means of exchange of programs, data, and text. Some magazine publishers use community bulletin boards as a standard means of accepting material for publication, and have automatic downloading and typesetting interfaces on their own systems to complete the publishing task. Such cottage industry applications are swiftly being supplanted by large-scale commercial services. There are major projects under way in Europe – such as GILT (Get Interconnection Between Local Text Systems) – to build links between different computer conferencing and message systems by developing interchange standards (Palme 1982, Sztanjkrycer and Karmouch 1982, Hauge *et al.* 1982).

The ground swell of demand has now been merged with the Videotex and PSS systems, and new products will condition the whole planning and participation process. The billion-dollar industry that provides data base information has already felt the sharp impact of distributed local-processor power with local storage and telecommunications linkages.

In parallel with these rapid developments, computer-aided group communication has been developing as an efficient and cost-effective tool. Electronic mail is an easily understood concept, but as the analogies to the telephone system become more apparent than the analogies to the physical mail system, the need arises for directories; for different levels of privacy and immediacy in communication; and for the ability to merge the text capture, text-processing, and publication processes into what appears to be a unitary environment from the other side of the terminal.

Developments in computer, audio, and video conferencing have taken place at different rates. Video conferencing and audio conferencing are specifically synchronous: all parties must be coordinated on-line, and only the spatial problems are overcome by this need for timing coordination. Much work needs to be spent (e.g. the South Pacific experience with PEACESAT (Semahu 1982)) on setting up timetables for these coincident timings to work. Nevertheless, such audio links have proved to be of considerable value in large regions such as the South Pacific, and even in small parts of this region such as Hawaii, which suffers from communication problems between the islands, although the archipelago is only a few hundred kilometers across.

The best tribute to this form of communication is that the suggestions that the new satellites to replace ATS-1, which is used by the PEACESAT consortium, would require more advanced and expensive reception equipment have raised widespread concern from the Pacific nations, who have come to realize some of the potential of ATS-1 through PEACESAT. Currently the need for asynchronous communications is being attacked, and computer networking over radio links, with a simple form of electronic mail, is now being set up.

Video conferencing systems have received what might reasonably be regarded as an unreasonable amount of attention. Certainly the concept of the videophone put forward by Hugo Gernsback in some of the earliest science fiction this century has been followed more because of technical capability than of market need. Extensive work has been done on the advantages or otherwise of synchronous communications to link more than one person.

The audio conference, where many speakers can share the aural parts of a conversation (usually by means of an audio bridge device supplied by the PTT), has become increasingly enthusiastically supported where the facilities have been made available. However, in most cases it is still necessary to make prior arrangements to set up the technical links, thereby vitiating some of the potential.

The extension of the synchronous aural conference to include visual information is an appealing idea, but requires a bandwidth of several megacycles as opposed to the few kilocycles needed for audio exchange. To date this has meant that the prior coordination efforts have made video conferences most suitable for regular meetings, and limited the ranges of application because of the need to reach the studios where the facilities are offered.

The delivery of the signal by direct satellite links will sharply alter these limitations, and make the video conference station a portable (or at least transportable) device requiring less spatial and temporal restrictions. The Satellite Business Systems studies of video conferencing (Hansell *et al.* 1982) consequently produced rather more positive results than had previously been obtained when these types of services were tested.

The asynchronous aspect of computer-aided communications is considerably underestimated. The term teleconferencing is currently used in a generic manner to cover video and audio conferencing – basically the synchronous modes – and the asynchronous systems of electronic mail and computer-aided conferencing are played down.

The spatial separations inherent in regional planning and coordination make the use of such systems between diverse organizations of considerable value. Communications for the development of the massive Australian Northwest Shelf for natural gas have been materially assisted by computer conferencing services, as it has required at the smallest scale coordination over the several thousands of kilometers between the Shelf and Perth within the state of Western Australia, as well as the transcontinental and international distances also involved in the network. Organizations such as the International Institute for Applied Systems Analysis are not the first to carry out distributed management of scientific (as distinct from engineering) projects (Vallee and Gibbs 1976), although the IIASA Telecenter system has been actively used for some time for this purpose (Lathrop and Pearson 1981).

The tools of the trade of information technology for integrated regional development are therefore becoming available in forms that link data gathering, data processing, data access, publishing, and delivery of subsequent results for decision support and monitoring. In the next section the means by which these links can be made usable will be considered.

3. Using the Tools of the Trade

The primary problem in using large-scale data systems is grasping the nature and structure of the systems used to organize the information. The underlying structure of many of the data base systems now available has become extremely complex, and requires special skills in information retrieval to drive them usefully or efficiently. This has certainly slowed down the penetration of the use of such systems, and the costs (in both communications and data base services) of learning on-line have inhibited many from looking in this direction. There are now new tools to service this specific need.

Substantial numbers of investors in the United States have automatic programs to "wake up" their home computers, dial an access number of an information utility, call up the Dow–Jones stocks data base, request the results, load them down on to the floppy disc of their own computer, merge the results with data sets collected previously, analyze the stocks, and store the results before putting the computer back to sleep again. Bibliographic data base specialists, such as Dialog and Orbit, have noted the sharp decline in connect-time sales with the introduction of 1200 baud access lines, as users switched over to off-line preparation of their enquiries and immediate downloading of the results on to local discs for review and reuse. The reaction of at least one of these specialists, BRS (Bibliographic Retrieval Services), has been to accept this trend and offer a microcomputer with a 20 megabyte hard disc and software tailored for this task, and offer a service of regular bulk downloading of the necessary updates from their data bases. This trend can reliably be expected to accelerate with the spread of TV cable services.

Another recently demonstrated major trend has been in improving the quality of access to some of the extremely complex data bases. For example, use of the massive Disclosure data base, which comprises all available company reports for the US, requires substantial training of information retrieval specialists. This is becoming increasingly uneconomic. Disclosure, Inc. is one of a number of information providers who have turned to expert systems techniques, and have created a microcomputer program that makes the information retrieval specialist unnecessary. This type of development is the harbinger of many more such highly intelligent and intensive-access demands for information. Recent privacy laws will make it difficult for official national statistical bodies to resist these developments for long, especially as a number of them now use the I.P. Sharp personal computer and many others to make their own time series of data available to their end users, in an environment with integrated analytic tools: APL and MAGIC, to pursue the (far from unique) I.P. Sharp example.

This trend in increasing machine intelligence at the user enquiry interface has gained fresh support and momentum from the steady improvement in the usability of the "knowledge-based systems" programming languages developing in the course of work on artificial intelligence. These have made accessible some of the methods of formalizing queries based on logical deduction from assertions and conditional statements that can be made about the situations under study. The best known language of this type is PROLOG (Programming in Logic) (Clocksin and Mellish 1981), and it is increasingly being used to link data base and logical deductive retrieval processes together into a single system.

This quintessentially academic language is being used effectively in applied environments already. British Telecom is using it to ease the interaction with its own Strategic Planning model, and numerous data base workers are now forging the links between relational data bases and such semi-intelligent front ends as British Telecom has undertaken to build

(Probert 1981).

A special feature of this BT approach is that it was recognized from nearly the start of the program that the normative numerical models underlying the different segments of the BT long-range planning system are *not* the key areas for attention. The user interface has been given particular attention, and the use of expert systems techniques for aiding the analyst and his senior management to gain in understanding from the use of the model system has led to the need for a system that can extract the lessons from the manifold of variational runs of the forecasting system, and at the very least draw the user's attention to areas of significance and association with the queries he has just initiated.

The cumulative effect of these movements – at the user interface and at data base structuring levels – is to shrink the gap between data insertion into the data base and the response to queries of the system that take account of the new material. The pressures already being induced by cheaper and better graphic systems to provide wider-bandwidth displays and responses to planning requirements may lead to larger amounts of information being provided at a more limited level of analytic reduction and synthesis.

This is unlikely to reduce the need for strategic economic analysis and forecasting, and may even increase the recognition of the need for it, but the expectation that high-density graphic displays of physical, economic, social, and demographic factors will be readily available can be counted upon to increase the pressure on regularly updated information and the linkages between different administrative sources of input.

The implications of extensive cross-linkage of different computer systems through packet switched data networks are important for regional planning and a strong catalyst for integration of the processes involved. The use of distributed computer processing power is already well established over such networks and is heavily used over dedicated lines between numerous academic centers in many countries. The parallel development of remote access to major data bases and searching systems over these networks has been a specific goal of the EEC Euronet. The development of distributed data bases, reliant on such networks for their integration, access, and processing, is the one that has greatest importance for regional planning.

The simplified access systems provided by Viewdata systems offer a highly effective way of expanding the services based on such systems, and – through the Gateways into other systems and to other types of services – the ability to gather data as well as request it. This "response page" aspect of Prestel has been used by BT to offer a gateway service from Prestel directly through to the on-line booking computers of Pan Am and other major travel carriers. The exploitation of this capability for gathering data will no doubt follow.

In summary, the tools now available and coming into wider use provide:

(1) Distributed data access
(2) Distributed data base retention
(3) Graphics-aided responses
(4) Interactive data-gathering capability
(5) Electronic mail
(6) Asynchronous communication, such as computer conferencing
(7) Intelligent tools for information extraction and aid and interpretation of results.

4. Implications for Data Collection

The expanded use of distributed data management systems will facilitate a greater decentralization of data acquisition without the loss of central coordination. It will also provide (potentially at least) the ability to redistribute the processing and input of information as a result.

In densely populated countries the expansion of video-bandwidth cable networks will provide novel interactive and friendly means of collecting data from households, business enterprises, and organizations. The Viewdata systems growing up, slowly, may yet offer further opportunities. The far greater present success of Viewdata as a system for operations of closed user groups and data capture is both a sign that this is a real possibility in the technical sense – and that it may not prove practical for household-based information, for lack of penetration. Viewdata is not the only interactive data collection system in prospect, however, and planners should expect others to emerge.

The technical opportunities for altering the approach of regional management and planning to data, from the slow reduction of mass cross-sectional data collections to the tracking of changes, and thus from a normative planning stance to a monitoring and control position, are becoming extensive. This does not mean that the political will is likely to emerge to make such a change practical rather than merely possible.

The ability of Viewdata systems to "narrowcast" information to a special interest group is of particular importance when the enormous diversity of regional planning needs is considered. Rice and Paisley (1982) report a typical case, where a farmer information system was set up and assessed in operation in the US. The significance of information access and immediacy in a farmer's everyday life already was a marked finding: the key result was that the farmers used the system, quickly and effectively, and the technique of Videotex delivery was appropriate, but it was also vulnerable to narrowcasting radio services when they started at a local level. The point of greatest interest is that the monitoring process and data collection system were built into the information delivery system. This trend will accelerate. Of significance for regional data providers is that this high level of distributed access to these data bases can also work in the reverse direction.

It may already be more economical to permit remote users to specify forms of analysis on-line, and the central data base computers only then produce the results. The protection of individual privacy from record linkage can be properly controlled, and major increases in the quality and speed of response to user needs can be obtained as well.

5. Implications for Regional Management and Integrated Planning

Modern information technology offers many perspectives for an appropriate use of all pertinent and available data for regional planning (see also Chapter 3). Some examples will clarify this relevance of spatially oriented information systems for regional management and integrated planning.

The lowest level of geographic detail in regional planning is exemplified by the land-parcel and public services inventory. It is when such geographically specific data become fully captured on electronic media that regional planning gains greatest benefit.

The diversity of information flows of crucial interest to regional planners includes flows of goods and of financial services and transactions. The flows of financial transactions are quickly becoming technically within the scope of semiautomatic data capture – but this would of course be resisted by the emerging interbank and common-carrier data networks. The place of the law and of regulation in this domain should be pursued by national statistical authorities, as their roles change over the next decade.

6. Social Acceptance

The increasing intrusiveness of coordinated data banks and the steadily increasing ease of obtaining sufficient computer processing resources to trace individual links through large data collections are contributing to a real sense of loss of privacy by individuals, business organizations, and the community. These pressures have become concrete in the form of data privacy laws, licencing of data holdings, and, on the other side, freedom-of-information acts. The nature and tensions in the changing balance between these opposing forces of retention of privacy and increased ease of correlation and coordination of electronically captured and transmitted data will be crucial for all aspects of planning.

The technical capabilities of data capture and record linkage that have already emerged are far beyond the general understanding of most of the population, and add a considerable burden of loss of confidentiality both to individuals and to organizations. In some economies these issues may be regarded differently, and the implementation issues will then dominate the discussion. In others the social balance will be sufficiently disturbed by them that such developments will not proceed far without the need for wide public endorsement being recognized. For example, the balance between the bank and individual interests in electronic transfer of funds has yet to be shown to offer much to the individual, but it undoubtedly has a great deal to offer to both banks and government.

A trend has become apparent in some countries, Japan being among the first to experience it, of an increasing resistance to government survey data collection. This social factor will become more acute if the new opportunities for data collection and use for integrated planning are not to be barred. In this connection it is important to note that Japan has long had very large-scale planning data banks.

7. Conclusion

The technical trends in computer and communications developments are altering the economics of large-scale processing, of immediate data reduction and acquisition, of presentation aids, and of management opportunities for coordination and decentralization. While all of these trends may be seen simply as increasing the support for present means of servicing integrated regional planning, it is highly unlikely that the social, managerial, and operational changes that they will bring will leave the processes of regional planning untouched.

References

Clocksin, W.F., and C.S. Mellish (1981) *Programming in PROLOG* (Berlin: Springer).

van Est, J.P., and L. Smit (1980) Geocoding: The spatial dimension of an information system. *Report*, Research Center for Physical Planning, TNO, Delft.

Hansell, K.J., D.Green, and L. Erbring (1982) Videoconferencing in American business: Perceptions of benefit by users of intra-company systems. *TeleSpan Newsletter* special supplement, 31 May.

Hauge, J.O., K.A. Bringsrud, J.E. Engebretsen, O.M. Johnsen, and K. Smaaland (1982) Interconnection of text systems. *Office Information Systems*, ed. N. Naffeh (Amsterdam: North-Holland), pp. 277–285.

Lathrop, C.L., and M.M.L. Pearson (1981) TELECTR user's manual. *Working Paper* WP-81-147, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Palme, J. (1982) The GILT CBMS interconnection standards – Introduction. *Report*, Stockholm University Computer Center (QZ).

Probert, D.E. (1981) Towards expert systems for telecommunications policy analysis. *Proceedings* of BCS Conference on Expert Systems (London: British Computer Society).

Rice, R.E., and W. Paisley (1982) The Green Thumb Videotex experiment: Evaluation and policy implications. *Telecommunications Policy* 6(3):223–235.

Semahu, S. (1982) PEACESAT AUSTRALIA Project. *Report*, Department of Electronics and Communications, La Trobe University, Victoria, Australia.

Sztanjkrycer, F., and A. Karmouch (1982) A proposal for interconnecting heterogeneous CBMSs in the GILT Project. *Office Information Systems*, ed N. Naffeh (Amsterdam: North-Holland), pp. 317–338.

Vallee, J., and B. Gibbs (1976) Distributed management of scientific projects. *Telecommunications Policy* 1(1):1–64.

PART

E

International Analysis of Regional Information Systems

Information Systems for Integrated Regional Planning
P. Nijkamp and P. Rietveld (editors)
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CHAPTER 18

A General Framework for Comparison of Regional Information Systems

Peter Nijkamp and **Piet Rietveld**

1. Introduction

Regional information systems are made up of three elements: inputs (regional data), outputs (information for regional planning and research), and the intermediate system serving to convert inputs into outputs. The aim of this part of the book is to see how these three elements are given concrete form for regional planning under different conditions in various countries. The six countries chosen for study differ in size, physical conditions, and planning systems: Sweden, France, the United States, the Netherlands, Czechoslovakia, and Finland.

These countries display considerable variety from the viewpoint of regional planning. For example, in France the competence of national authorities is large compared with that of regional authorities. In some of the other countries, the regional authorities have considerable competence in some fields of planning. There are also significant demographic differences: for example, the Netherlands are densely populated, whereas Finland and Sweden are not.

A problem with comparative studies of this kind is that usually only a small number of cases (countries) can be studied, whereas many variables are involved. This hampers the formulation of generalizations that satisfy usual statistical requirements. As indicated by Masser (1981), a solution would be to select the "most similar cases." This means, in a statistical sense, that there has to be a large measure of control in defining features that must be common to all cases. A disadvantage of this approach is that it is rather demanding in terms of the theory needed prior to defining the relevant common features.

In this comparative study we have adopted another approach, since a well developed and uniform theory of regional planning and information systems does not exist. Our main concern is not so much the formulation of generalizations but rather the exploration of a relatively unsurveyed field. An important aim is to show the variety of regional planning and information systems that have developed. Therefore, we have included, for example, both a country with a centrally planned economy (Czechoslovakia) and a country with a low intensity of planning (the United States).

For each of the countries one or several experts have been invited to write a national report on the regional information systems in use. In order to achieve as much comparability as possible, a general framework was developed to guide the presentation of each national report. Clearly, this approach may run the risk that a contribution from a centrally planned economy might not completely fit into the strict framework that we set out in this chapter. We are content that a contribution could be obtained from Czechoslovakia, although we are aware that in some respects the fit is not complete.

The general framework consists of two dimensions. Firstly, regional planning is given a more precise meaning by introducing a reference system that includes various planning components (Section 2). Secondly, various aspects of regional information systems are dealt with: data, technology, and information produced (Section 3). By combining the two dimensions one arrives at a matrix structure for the national reports, which is presented in Table 2. After the six national reports (Chapters 19–24), a chapter will be devoted to a comparative review in order to draw conclusions regarding marked similarities and dissimilarities among the information systems described.

2. Regional Planning

Regional planning may be regarded as any activity (or set of activities) that aims at achieving certain goals for a regional or multiregional system. In these broad terms, regional planning (territorial planning, planning of territorial production complexes, etc.) may encompass various components, such as:

- economic and industrial planning
- land-use planning
- manpower and labor market planning
- housing planning
- transportation planning
- infrastructure planning
- financial planning
- environmental planning
- energy planning
- social planning

- facilities planning.

This list, by no means exhaustive, shows that regional planning addresses a wide range of issues. It would not be worth while here to focus attention simultaneously on all kinds of information systems that might be designed for the above-mentioned issues, as this would lead to a disintegrated methodology. Instead, we will present a systematic but simplified picture of some key components of a regional system. This representative system will be referred to as the *reference system*, since it will provide the basis for our international comparison. This reference system is not meant to be normative, but to help produce a logical and integrated view of the necessary information base for regional planning.

The main focus of this reference system for integrated regional development planning is on the spatial interactions between various basic activities taking place in a regional or multiregional economy. In this way, geographic activity patterns (e.g. labor and settlement patterns), land use, transportation, infrastructure, and natural resources may be taken into consideration in a coherent framework. The reference framework is represented in Figure 1, where the main emphasis is placed on the linkages (direct or indirect) between the household sector and the production sector. A more extensive version might be developed, but for ease of international comparison of regional information we will mainly use the system of Figure 1. The *components* of the reference system are each represented by one of the shapes in the figure. This system may relate to both single- and multiregional systems, so that interregional commodity flows, etc. may also be taken into account.

It is important to note that the most relevant spatial scale is not the same for all planning components. Let us, for instance, interpret a region as a functionally interdependent labor market area with strong internal commuting flows. Then it is clear that for economic, industrial, and labor market planning, such a region is the basic spatial unit. The same applies to the planning of migration. Thus, these planning components have a typically *interregional* character. On the other hand, land-use planning is usually concerned with *intraregional* issues, such as suburbanization. The same holds true for housing policies.

An intermediate position is assumed by transportation, infrastructure, and energy and environmental planning. Here the predominant regional level depends considerably on the kind of issue concerned. This argument is summarized in Table 1.

The contents of Table 1 are important when analyzing the competence of planning agencies at various spatial levels (national, provincial, county, municipal). There is clearly more scope for intensive planning activities at a low spatial level in the case of land-use planning than there is for industrial planning. Consequently, the need for information with a high spatial detail will be much larger in some planning components than in others.

Two main viewpoints influence the aims of regional planning. The first is that the main goal is to promote national economic efficiency. In this

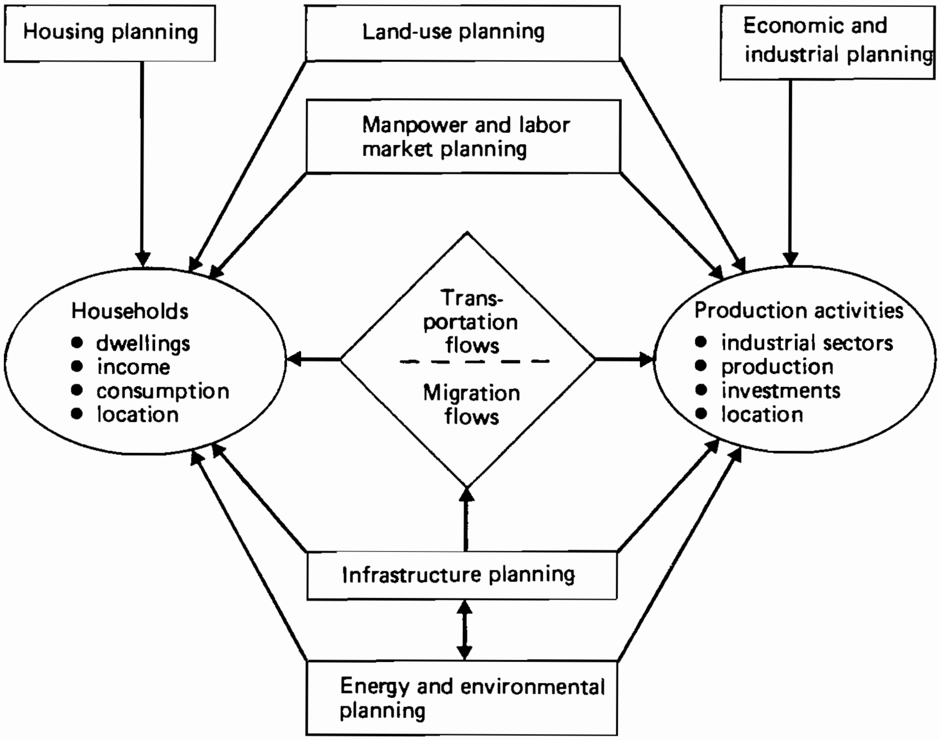

Figure 1 The reference system.

Table 1 Predominant spatial level of various planning components.

Planning component	Level of planning	
	Intraregional	Interregional
Land use	•	
Housing	•	
Infrastructure	•	•
Energy and environment	•	•
Transportation	•	•
Economic and industrial		•
Manpower and labor market		•
Migration		•

case, the objective of regional planning is an interregional reallocation of population, investments, and infrastructure so as to achieve interregional efficiency. This emphasis on national efficiency is predominant in centrally planned economies. Efficiency is also the predominant aim in pure market economies, the antipode of centrally planned economies. The difference between the two of course concerns the extent to which market forces are allowed to contribute to efficiency.

The other viewpoint is mainly fostered in the mixed economies of the West European type. Here the predominant reason for regional planning is the desire to reduce interregional welfare discrepancies in terms of employment, income, and infrastructure (Snickars *et al.* 1982).

The regional planning system of each country depends on the political and institutional conditions of the country. Some countries may have a bottom-up planning structure, others a top-down or mixed structure. In some countries, regional planning may be the responsibility of a single public agency (e.g. a ministry of regional development), in others various ministries are involved. In some countries, regional planning is mainly oriented toward physical planning, while in others it is almost exclusively toward economic and industrial planning. In general, there is a tremendous variation in planning activities, varying from so-called *facet* planning, characterized by emphasis on one component without consideration of the others, to *comprehensive* planning, characterized by an all-encompassing master plan. *Integrated* planning may be regarded as an intermediate form that aims to coordinate various planning activities without, however, the high ambitions of a comprehensive master plan.

Planning may focus on incremental changes or on integral changes in a spatial system. It is of course especially important to know the problem orientation of the information in relation to the regional planning. Clearly, the depth and scope of planning activities determine the required size and accuracy of an information system. The structure and purposes of information systems are also determined by the aims of the planning activities at hand, such as description, impact assessment (including modeling and forecasting), and evaluation (including decision making).

3. Regional Information Systems

3.1. *Introduction*

Having delineated a reference system for regional planning, including several planning components, we will now deal with the information systems developed to serve regional planning. The following subjects will be covered: general features, data collection, contents and quality of the information produced, information technology, the actual use of information systems, and perspectives. Thus, we arrive at the framework, shown in Table 2, for the description of regional information systems. This table is used as a guideline for the description of the regional information systems in various countries in the following chapters.

Table 2 A matrix representation of an integrated information system for regional planning.

Attributes	Spatial reference system as a whole	Individual components							
		Individual planning components						Interactive planning components	
		Housing	Land use	Economic and industrial	Manpower and labor market	Infra-structure	Energy and environment	Transpor-tation	Migration
Regional planning system									
General features of information systems									
Collection of data									
Contents and quality of information									
Information technology									
Use of information systems									
Perspectives and recom-mendations									

3.2. *General Features*

The notion of integrated regional planning has its counterpart in the notion of integrated regional information systems. Thus, an important question is to what extent regional information systems are integrated across spatial levels and planning components. Several factors hinder this integration. Firstly, coordination is difficult from a scientific point of view, since side effects of a certain planning field on others are often hard to assess. Secondly, the coordination gives rise to conflicts of competence among planning agencies and political bodies at various spatial levels. These factors obviously obstruct the coordination not only of planning activities but also of information systems. Therefore, they deserve attention in an international comparison of integrated information systems.

An obvious test of the adequacy of an information system is whether it has something meaningful to say on policy issues. Two time lags should be mentioned in this context. Firstly, once an issue has received political recognition, it may take time before the information systems are adapted to the new need for information. Thus, it may be expected that information systems tend to be more relevant for problems of the past than for problems of the present or the future.

Secondly, it usually takes time before a certain issue receives so much attention that it becomes a political issue. Many issues only gain political character after having been latent for a long time. Well known examples are environmental decay, energy scarcity, and (recently) innovation. Thus, information systems can be made more adequate by broadening their scope from political issues to latent issues that may later become political (see also Section 5 of Chapter 1 on adaptive information systems). Therefore, an even harder test of information systems is their ability to help one identify the latent issues that will probably achieve political status in the future. This test requires that forecasts can be produced not only on actual states but also on political priorities. This last type of information is clearly qualitative.

3.3. *Data Collection*

Data are the inputs of information systems. In some cases, such as a normal population census, data are collected for the purpose of feeding information systems. Then, the concepts and definitions used in the census can be directly adapted to the purposes for which the information system will be used. In other cases, secondary data are used. They are based, for example, on administrative registers of dwellings, the unemployed, or tax payments. An obvious disadvantage of secondary data is that the concepts and definitions that they embody may not match the aims of the users. An advantage is that they are usually less expensive. In addition, they are often collected continuously, which makes them very useful for planning purposes, given the continuous character of planning (see Chapter 4 by Batey).

Integration of regional information systems requires the standardization of concepts and regional classifications used in data collection. A high level of integration can be obtained when data files with individual observations can be linked. In some countries such linkage is possible because of the use of individual identification numbers for persons and firms.

3.4. *Contents and Quality of Information*

Various aspects of the contents and quality of the output of information systems can be distinguished.

Scope. The range of phenomena that an information system deals with comprises not only the number of planning components but also the kinds of variables covered by each component. In this respect qualitative data and data on interregional flows should be mentioned.

Degree of detail. The usefulness of information systems depends considerably on the possibility to produce information at a highly detailed level. In addition to spatial detail, there is also sectoral detail for describing firms and occupational detail about employees, for instance.

Reliability. Measurement errors may substantially reduce the quality of information systems. These errors may be due to, among other things, intentional or unintentional mistakes of respondents, obscure questions, inappropriate sampling techniques, and mistakes in data processing.

Validity refers to whether data really measure what they are intended to measure. Problems may arise, especially when secondary data are used.

Coherence refers to the standardization and synchronization of data for different variables. Coherence is a prerequisite for integrated information systems.

Time aspects. Various time aspects can be mentioned. Examples are timeliness, the length of time series, and the frequency of observation.

3.5. *Information Technology*

Information systems may differ significantly in the degree of computerization. Some systems are not computerized at all: their output usually consists of statistical publications for general purposes and nothing more. It may be extremely difficult and time-consuming to use noncomputerized systems for specific purposes. Computerization may be introduced at various points, such as data collection, data storage, data editing, use of data banks, and distribution of information. Obviously, the degree of computerization has a substantial impact on the forms of communication between system and users.

3.6. *Use of Information Systems*

Information systems can be used for at least two purposes: planning and research. It should be remarked that these two are not independent. Research may produce results that are useful for planning; it may also give rise to the construction of models that later become incorporated in information systems to generate forecasts or impact assessments.

One main aspect of the use of information systems is their accessibility; they may sometimes be restricted to only a few agencies. It is also interesting that very often data are available at statistical offices, but have never been officially published. Further, in some cases the contents of an information system are determined by the users (e.g. planners), while in other cases the research needs of experts and analysts determine the contents.

Several kinds of barriers may prevent extensive use of regional information systems: institutional barriers, technological problems, high costs, and, last but not least, low relevance and low quality of the information produced (Section 3.4). The bottlenecks encountered when using information systems for regional modeling are discussed by Issaev *et al.* (1982), as well as by Peters in Chapter 3 and Rietveld in Chapter 9.

3.7. *Perspectives*

Developments in the sphere of regional planning and information technology have been rapid in recent decades. It is not surprising, therefore, that in most countries regional information systems have not reached a balance either with the planners' needs for information or with the opportunities offered by advanced information technology. It would be interesting to know how further developments of information systems are being considered in various countries to restore these balances.

4. Concluding Remarks

It is clear that the subject matter of this comparative study is very broad. An integrated analysis of regional planning and information systems is certainly hard to carry out. The difficulties are nicely illustrated by Table 3, which lists a number of key dimensions in planning that jointly determine the complexity of this activity. It is striking that the planning situations considered in the comparative study fall into the "difficult to deal with" category for virtually all dimensions. It will be clear, therefore, that the conclusions to be drawn in the review of the national reports (Chapter 25) can only be tentative.

Table 3 Key dimensions in planning situations (source: Masser 1982).

Dimension	Planning situation	
	Easy to deal with	Difficult to deal with
Specificity	High	Low
Number of groups affected	One	Many
Character of negotiations	Dominant actor among participants	No dominant actor among participants
Degree of agreement, in terms of awareness, priority, and intensity of concerns	No conflict with existing value system	Major conflict with existing value system
Impact on organizational structure	No reorganization required	Significant reorganization required
Impact on resource allocation pattern	No change	Significant change
Impact of external factors in internal negotiations	Reinforces existing tendencies	Counteracts existing tendencies
Technical difficulty, in terms of comprehension of causation and complexity of technology	Within existing technological tradition	Radical change from existing technological tradition

References

Issaev, B., P. Nijkamp, P. Rietveld, and F. Snickars (eds.) (1982) *Multiregional Economic Modeling: Practice and Prospect* (Amsterdam: North-Holland).

Masser, I. (1981) Comparative planning studies: A critical review. *Report*, Department of Town and Regional Planning, University of Sheffield, UK.

Masser, I. (1982) The analysis of planning processes: Some methodological considerations. *Environment and Planning* B 9:5–14.

Snickars, F., Å.E. Andersson, and M. Albegov (1982) Regional development modeling – Theory and practice. *Regional Development Modeling: Theory and Practice*, eds. M. Albegov *et al.* (Amsterdam: North-Holland), pp.3–25.

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P. Nijkamp and P. Rietveld (editors)
Elsevier Science Publishers B.V. (North-Holland)

CHAPTER 19

Information Systems for Integrated Regional Planning and Policy Making in Sweden

G. Guteland and **O. Nygren**

1. Introduction

It is not an easy task to provide a summary report on information systems for integrating regional planning and policy making. One reason is that the topic is a very broad one. Another is that the difference in Sweden between regional planning and regional information systems is not quite clear.

In our national report, we have tried to distinguish between the planning system, the information system, the statistical system, and information about objects and events. The planning system deals with intra- and intersectoral goals and procedures. The information system gives forecasts and analyses of developments, using statistics and other types of information. The statistical system includes production and distribution of statistics, and uses information from data bases and special enquiries.

It is difficult to make an exact distinction between the four levels. For example, Statistics Sweden is increasingly making statistical analyses. This means that the bureau contributes to both the statistical system and the information system. At the regional level the county planners work with the planning and information systems and also with statistical analysis. The plans are sometimes just forecasts or descriptions of development, to be used as background for planning in different sectors at the regional and local levels. Sometimes these sectors produce statistics of their own and also create their own information systems. At the local level, collections of statistics for use in planning are common.

In this chapter we shall describe the different systems and offer some recommendations and perspectives.

2. Regional Planning and Policy Making

2.1. *Background*

2.1.1. The state

A basic characteristic of the Swedish Civil Service is that it is organized at two separate levels: the ministry (*departement*) and the agency or board (*ämbetsverk*). The former is primarily responsible for the framing of policy, the latter primarily for its execution.

The state has a fairly large regional administrative network, which is, as a rule, based on the counties (*län*) as administrative districts. There are 24 counties in Sweden and each has a County Administrative Board, headed by the Provincial Governor. There are also special regional boards for certain branches of the administration, each of which is directly subordinate to the respective central board. There is, for example, a County Labor Market Board, a County Board of Education, and a County Housing Board.

The sectoral structure, which is a feature of organization on both the national and the regional level, allows each administrative sector to be largely responsible for the geographic distribution throughout the country of the funds made available by the national budget.

2.1.2. Local government

A characteristic of the administrative structure in Sweden is the amount of responsibility in the hands of the local government and its importance to community development. It is for this very reason that a particularly strong need has been felt for an adjustment of the local administrative system to meet the new requirements made by community development. To this end, extensive changes in the local government pattern were conceived and, to a large extent, implemented during the last twenty years.

The basic political decision-making body at the local level is the commune. The functions and powers of the communes were strengthened by the local government reforms of the 1950s and 1960s. There is, however, a municipal body at the regional level that has certain characteristics in common with the communes. This body is named the County Council (*Landsting*) and is mainly responsible for health and medical care within the county.

Both communes and County Councils have two types of duty. The first type comprises duties that, unless such matters are to be dealt with by some other authority, the communes have the right to undertake at their own discretion, although they are not obliged to do so according to the legislation governing their activities. This "free" sector covers matters such as recreational facilities, libraries, theaters, and local transport. The second type consists of duties delegated to the communes by the government. This official administration includes social welfare, building and planning, public health, and energy.

The local authorities have the right to levy income taxes and receive the revenue of a tax on real estate, and they charge fees for various services. Considerable grants in aid are distributed to the communes from the state budget to cover costs in connection with the compulsory duties mentioned above. Communes and County Councils are independent of each other, have decision-making assemblies elected by the public, and have their own powers of taxation.

2.2. *National Planning*

Planning in Sweden is summarized in Figure 1. As a rule the responsible authorities in each sector of society have to see that plans are drawn up for developments in their different sectors. These plans, or in some cases the reports of special commissions, provide the basis for accounts that, in turn, lead to annual resolutions adopted by the government and Parliament. In these resolutions the requirements of the different sectors are balanced against one another according to the resources available. The sectoral authorities are then responsible for executive planning within the bounds defined by government resolutions.

2.2.1. Central economic planning

Economic planning in Sweden is subject to certain fundamental principles concerning management of the economy and the conditions under which economic policy operates. The primary principles are that consumers shall be free to choose, a clear assertion of a liberal trade and tariff policy, and freedom in such matters as choices of vocation and establishment of business.

The Long-Term Surveys deal with the whole economy, their primary purpose being to present and analyze trends in the economy, primarily in the medium term (5 years) but to a certain degree with a 15–20-year horizon as well. The surveys are not a program for the Swedish economy but informative and guiding instruments for the political and other public and private bodies that have the task of formulating lines of action in the long term. The forecasting nature of the surveys also applies to the public sector, the chief aim here being to create a background and joint frame of reference for discussions about forthcoming political decisions and to give these a long-term perspective. The Long-Term Surveys further provide a natural opportunity for coordinating the assumptions about future prospects, which serve as a basis for planning in the public sector and by private firms.

2.2.2. Planning for regional development

In Sweden, the foundation for a specific policy for regional development was laid in 1964 when Parliament approved an active location policy. The goals of regional development policy were further elaborated by Parliament in the seventies in the light of the experience gained. A prerequisite for this has been the increasingly systematic regional development

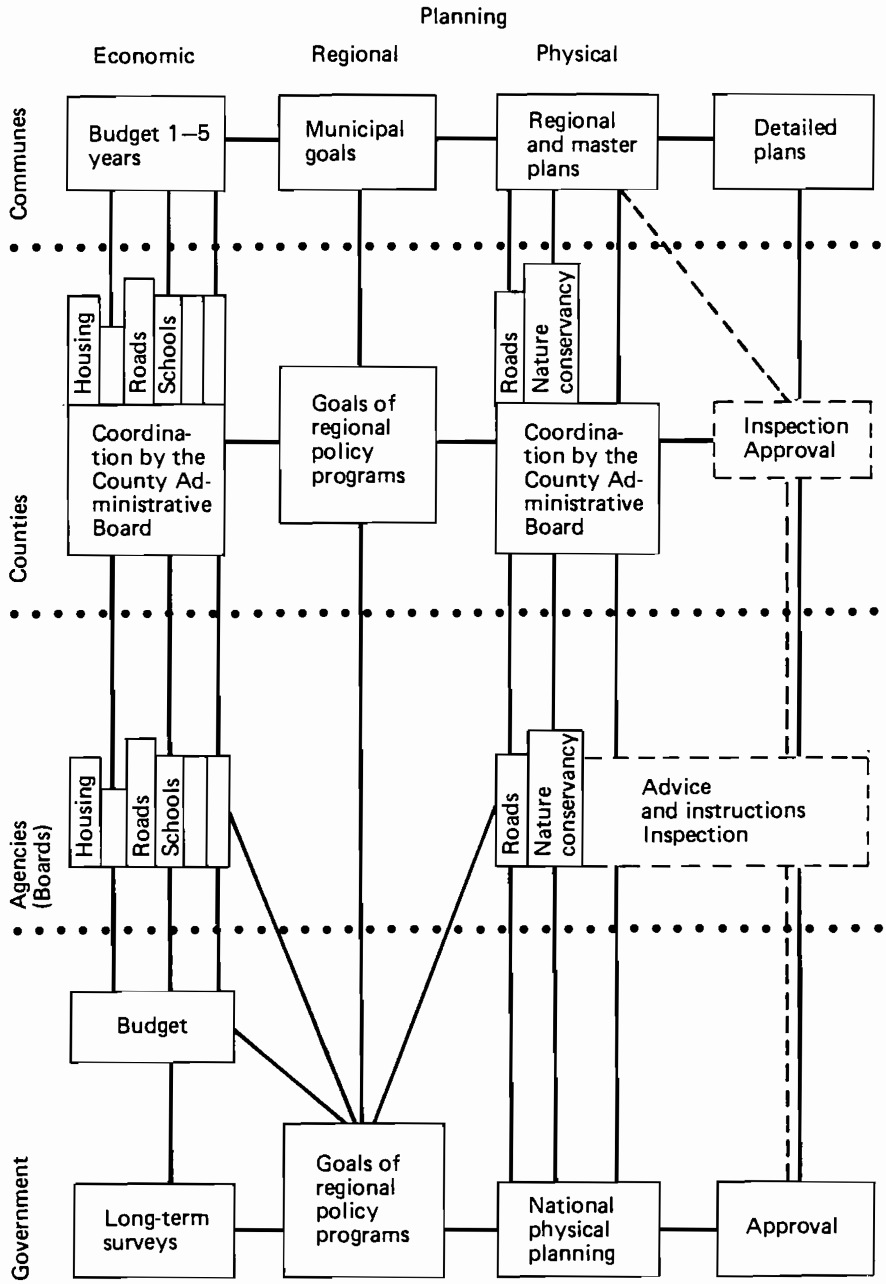

Figure 1 Planning that is normally conducted sector by sector is represented by columns (vertical planning), while planning involving more than one sector (cross-sectoral or horizontal planning) is indicated by rows (source: Thufvesson and Svensson 1981).

planning, which has been pursued since 1967.

The general goals of regional policy in Sweden were recently formulated in the following way (Ministry of Industry: Swedish Regional Policy 1982): "The aims of regional policy are to create conditions by which a stable population trend can be maintained in the different parts of the country and to give people access to jobs, services, and a good environment regardless of where they live in the country."

To achieve these objectives, the government and Parliament have designed a set of regional policy measures and have specified guidelines for the implementation of regional policy. The Ministry of Industry is responsible for certain regional policy measures. In the implementation of regional policy, certain guidelines have to be prescribed for the priorities of different regions. The national guidelines traditionally used in Sweden are threefold: population frames, a regional structure plan, and the designation of regional development areas ("subsidiary areas").

In a system where decision making is largely decentralized, efforts to implement a coordinated regional policy presuppose that the various sectors of society have a common basis for decisions on the location and dimensions of various activities

The availability of housing, schools, communications, etc. is of great importance to regional development. The main responsibility for the planning and expansion of these kinds of amenities rests with the communes. In certain cases government aid is available for the creation and maintenance of the necessary buildings and installations.

2.2.3. Transportation

In various ways, national policy in the transport sector takes into account the connections existing between the development of this sector and the development of the demographic and economic structure in different parts of the country. One of the fundamental principles governing state initiatives in the transport sector is that they must be in accordance with goals of regional, employment, and general economic policy.

The regional transport plan commissioned by the government from the County Administrative Boards for 1974 is to be seen in these terms. The purpose of this plan, with due allowance for population structure, economic conditions, and existing and anticipated demand for transport services, is to put forward proposals for the optimum provision of adequate regional transport facilities, according to the need.

The need for transport planning is also in evidence at the local level. Regional and local planning need to be coordinated and therefore planning at county level is accompanied by local transport planning on the part of the communes.

2.2.4. National physical planning

Apart from the problems of regional balance mentioned previously, the course of social development has also given rise to problems of another kind requiring countermeasures in the form of state long-term planning. It has happened with increasing regularity that demands have been made from different quarters for the utilization of identical resources of land and water that are of outstanding value from a variety of angles. In situations of this kind, those wishing to exploit natural resources have generally been able to assert their interests more easily than those wishing to keep an area in its unspoiled state. Conflicts on environmental issues have attracted progressively greater attention because of an increasing realization of the vulnerability of nature to different kinds of interference and of the long-term consequences of the inept exploitation of natural resources.

Thus long-term planning of the use of natural resources with a view to the prevention of environmental damage and conflicts over these resources has become an increasingly urgent necessity. In view of the nature of the conflicts involved, planning of this kind must be given a perspective whereby the entire country can be considered as one continuum. Accordingly it is both natural and necessary for the state to have assumed direct responsibility for this planning.

Factors of fundamental importance in determining the scope of national physical planning include the manner in which this planning is to take account of ecological assessments and matters concerning environmental developments generally, as well as the desirability of economic growth. The time perspective on which planning is to be based is another highly important consideration.

The guidelines for land and water management established by Parliament are couched in very general terms and the principal responsibility for their implementation rests with the communes. National interests will ultimately be provided for in the context of municipal physical planning. This presupposes a process of interaction between government and commune, enabling municipal planning authorities to specify and develop the centrally formulated guidelines and to influence their continued formulation. No significant departures may be made from the guidelines without Parliament being consulted.

2.2.5. Energy

According to the government proposals, Sweden's energy policy should aim to reduce the annual growth in energy consumption from a postwar average of 5% to 2% during the eighties and to zero from 1990. However, this is not a goal in itself. The basic idea is that the energy system should be transformed so as to reduce its environmental impacts as well as the country's dependence upon imported fuels. This transformation should, according to the government proposals, neither conflict with important social and economic goals nor lead to dramatic changes in electricity supplies. The above-mentioned growth figures were thus regarded as a reasonable compromise.

2.2.6. Housing and building

The quantitative goals of Swedish housing policy, in terms of standards of equipment and space, are generally considered to be achieved. The building activity in the next decade will be restricted to compensation for demolition. The age structure of the dwelling stock calls for considerable renewal, taking energy saving and improved access into account.

The planning of housing, in terms of housing consumption distribution and equalizing housing costs, is carried out by the state. The housing market in Sweden is to a wide extent regulated by the state through subsidies. The planning of building is carried out through interaction between local government and municipal and private construction firms. Legally, the planning is restricted to local government. National guidelines are worked out in the Long-Term Survey, and now and then the state provides economic stimuli. In the seventies, regional development planners were strongly engaged in distributing the building activity between municipalities by restricting government loans. Today, building activity being low, it is not an effective instrument in regional planning. Consequently, housing and building are not discussed very much in regional development plans.

3. Regional Information and Statistical Systems

Referring to the introduction, we separate this description into two parts, the information system(s) and the statistical system, while comments on information about objects or phenomena will be given in Section 4.

3.1. *Information Systems*

3.1.1. County planning

The mandatory elements in county planning are the following:

(1) the forecasting of employment and population trends, and the analysis of regional problems;
(2) the specification of objectives for the development of the county in accordance with national objectives and guidelines laid down by the government and Parliament;
(3) the formulation of guidelines to govern the use of regional policy measures at the disposal of each County Board, and of guidelines for other regional authorities whose activities are of importance for regional development.

County planning is carried out in close cooperation with the municipalities and the other parties concerned in the county. The forecasts made by the County Boards are of considerable importance in planning at the municipal, regional, and national levels. They also provide data that can serve as a basis for governmental decisions on regional policy.

The forecast model used is common for all regions. Roughly, the model is constructed so that the demand for labor is appraised first. The supply of labor is estimated by a demographic projection and application of employment rates. The difference is supposed to be net migration. The calculations of the demand for labor are for some sectors – industry, trade, and building – worked out in special submodels. For other sectors, including the public sector, the assessments are based on a mixture of trend analysis, national forecasts, local and regional investment plans (public sector), and informal contacts with private firms. The labor demand is adjusted with a figure for the assessed net commuting rate. In forecasting employment rates, cohort-based trends and the demand for labor are considered. The labor supply is not distributed into sectors in the model.

Demographic age-specific factors, such as birth, death, and migration rates, are all based on historical data specific to each region. Usually, a splined average over the latest five years is used.

In practice, the forecasting work is carried out iteratively. The balancing factors – employment, net migration, and net commuting – are adjusted until a reasonable result is achieved.

A flow chart of the forecasting model is shown in Figure 2. The forecasting system was constructed in 1970. In 1976 it was computerized at Umeå University. The system is financed by the Ministry of Industry, which is also responsible for supplying the historical data base for the model. The forecasts are worked out by the County Boards in an interactive system. The data base is updated whenever new data are collected: yearly for demographic data, but only every fifth year for the other components in the model.

Regional development planning does not take economic variables explicitly into consideration. It deals with population and employment concepts only. Another drawback is the inconsistency between the summarized regional plans and the national plan (forecast). Therefore, since 1975 the forecasts in the Long-Term Survey for the whole economy have been broken down into eight regions (aggregates of counties). The analysis, in terms of resources devoted to model development and consistency testing, is, however, not very ambitious. The Lowry model is used, working only in terms of employment. Regional differences in capital structure are not taken into consideration. Earlier efforts to implement an input–output model have been restrained, mainly owing to lack of regional input–output data.

There is also a cumulative information system dealing with economic data, which is based on local government plans (KELP). Data concerning planned investments, consumption, and employment over a five-year horizon are collected yearly by the Regional County Boards. After analysis and consistency testing, the material is delivered to Statistics Sweden and the National Housing Board. The summarized data form an important

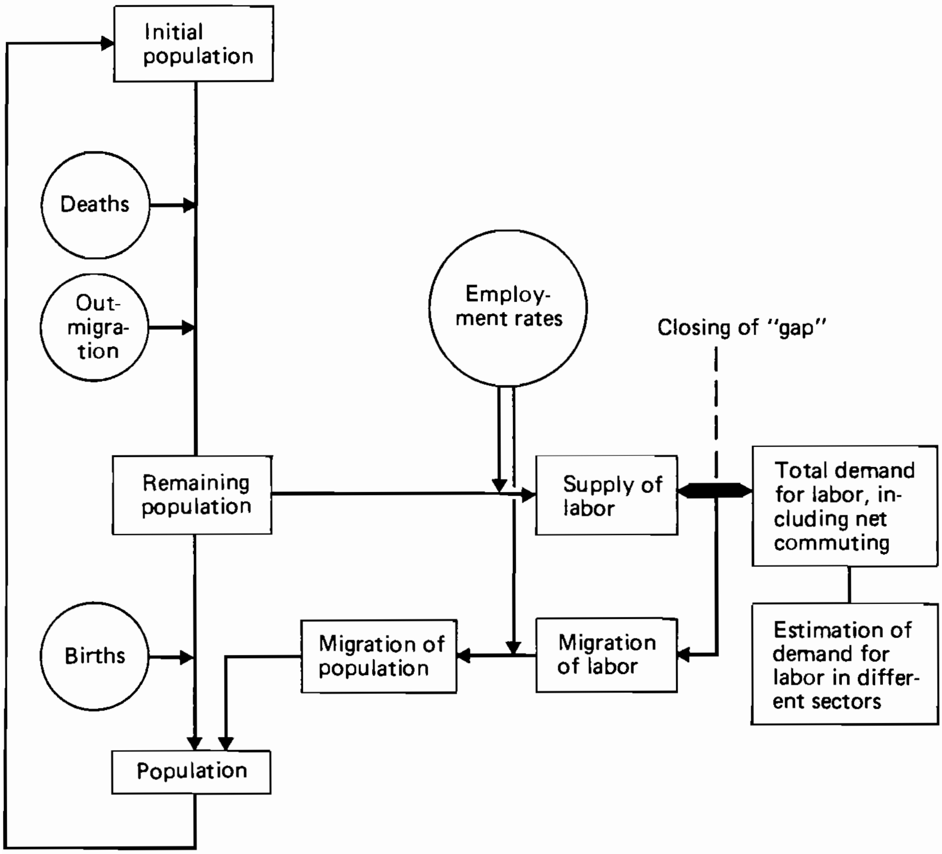

Figure 2 The forecasting model used in Swedish regional development planning.

component in the negotiations between the state and local governments about local taxes and transfers between the state and municipalities. For the County Councils, there is a similar system, LKELP, which assembles data on such matters as health care.

3.1.2. National physical planning

National physical planning (NPP) is still in a development phase. Some of the guidelines are soon to be established in the Swedish law for planning and building. Ninety-five percent of all municipalities have by now worked out plans for the whole municipal area. The work on design of an information system is to be started in 1983, after establishing rules for the interplay between the national, regional, and local authorities (Figure 3).

The responsibility for maintaining the information system will fall on the County Boards. Up to now, county inventories and national overviews have been worked out by the sector authorities. These products are

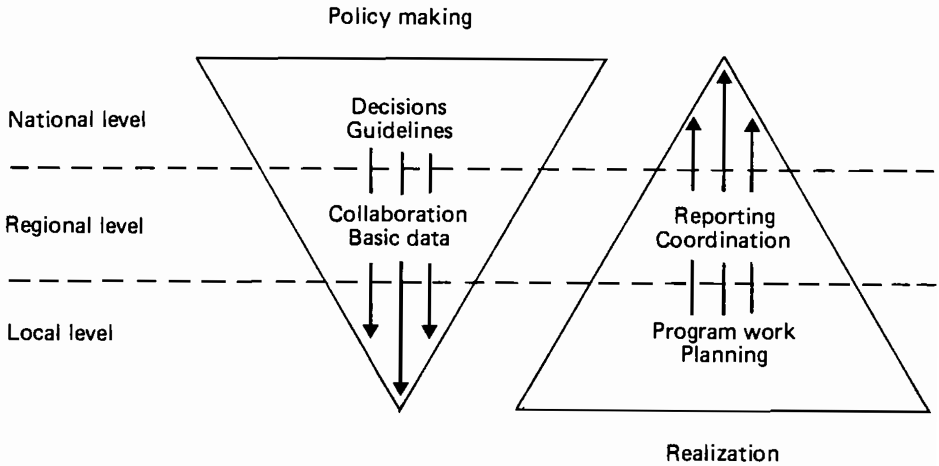

Figure 3 Interaction between local, regional, and national authorities in national physical planning.

documented on maps on a scale of 1:250,000. They include areas required for agriculture, forestry, tourism and recreation, polluting industry, nature conservancy, cultural conservancy, roads, and leisure housing.

The maps have been digitized into a computerized pilot information system, called the NPP data base, with a spatial specification in 5 km squares. For each such square, quantitative and some qualitative measures are specified. The aims of the system are:

- to point out areas with certain qualifications for location of polluting industry;
- to show the amount of land demanded by several activities;
- to explain the connections between human activity and the natural qualities of land;
- to give quantitative descriptions of the amount of land demanded by various activities.

So far, the system has mostly been used for small-scale map production, covering the whole country.

There are two basic problems in creating an information system for national physical planning: representation of qualitative data, such as evaluating different degrees of demand, and the spatial distribution. Methods for evaluating different land-use demands (recreation, nature conservancy, etc.) have not yet been developed. A classification of arable land in ten categories is so far the only result of the ongoing efforts. So-called "areas of primary interest" have been established for a number of activities.

The spatial distribution of these areas is represented by grids. A major problem in integrating grid-represented qualitative aspects with conventional statistics, such as population and housing, is that grid representation of the statistics is not yet available. Spatial distribution in Swedish statistics is generally based on the real-estate unit. A project to connect the real estates with grids is still not finished, and the work is proceeding fairly slowly. This has delayed the development of grid-based information analysis systems.

In a statistic-rich country like Sweden, we still face the fact that land-use information is insufficient. A reasonable explanation might be that the country is sparsely populated, and the land-use conflicts are, from an international view, very few and concentrated in the southernmost coastal areas.

3.1.3. Transportation

Overall regional transport planning can be looked upon as just an information system. In the late seventies inventories on goods and human transport, as well as plans for investments in infrastructure, were made by the Regional County Boards.

The most successful part of the planning process has been the development of the public medium-distance transport system. The basic information sources are statistics and regional inventories on commuting patterns, focused on the rural areas. The demand for public transportation is calculated using models that account for the distribution of housing and employment, car commuting frequencies, and assessments of future car density and fuel price.

The lack of information about goods transportation has been a serious deficiency in working out plans and guidelines. As to local investment plans, the regional authorities have not had sufficient impact on local decisions.

It seems less probable that a specific information system will be established exclusively for traffic planning. More likely is an integration with regional development planning. The fact that traffic planning and regional development planning are organized by different ministries might, however, be an obstacle to such integration.

Governmental road planning is highly integrated between the national and regional levels and uses a common information system, called the road data bank, which is an efficient planning tool. This computerized system includes data on all government-financed roads. The roads are represented by links limited by nodes (crossroads, bridges, etc.). The nodes are spatially represented in a grid system. For every link, there is information about technical details (width, paving, height profile), traffic flows, accidents, and speed limits and other rules. The system is being constructed in stages. The first stage was finished by 1978. The current stage is aimed at further development of routines for analyses and graphic representation. Today the system is already very powerful.

Social accounts are an important instrument in road planning. Project costs are related to benefits in terms of increased security and access, reduced noise, and even regional policy. Every fifth year, plans are made for a ten-year period.

3.1.4. Housing

The local authority housing construction program (KBP) is the basic component in the housing information system. It is linked to the long-term economic planning of the municipalities (KELP). The program is divided into two parts, one for assessments of future housing needs, and one for the planning of construction, including spatial distribution. The program is based on population forecasts and assessments of future household formation for the municipality as a whole. The planning of spatial distribution is closely linked to physical planning.

Since 1980, plans for rebuilding have been included in the KBP. In the near future, so-called social housing inventories, including data on standards of living, will be an important part of this program. The KBPs, which are worked out yearly for a five-year horizon, are integrated by the National Housing Board.

The summarized KBPs are evaluated against the national housing plan, worked out in the Long-Term Economic Survey. This plan is based on a forecast, using an econometric model that includes three basic components: real income, housing cost, and age distribution. These components are expressed as aggregated elasticities.

In recent years, Swedish researchers have developed new methods. Disaggregated demand models, based on local or regional housing markets and the distribution of demand for different types of housing and forms of possession, will probably be used on the national as well as the local level. New models for household forecasting are also being developed, but the necessary flow statistics are still not sufficient.

3.1.5. Energy

Local and regional energy planning started without an adequate information system because of the urgent need for such planning. Energy balances have been worked out on a national level, using sampled information.

At the local level, planning is divided into two parts: energy saving, and substitution of oil consumption with coals and domestic fuels. An information system for energy-saving planning is now being constructed by the Municipality Association (*Kommunförbundet*). The system, which is being computerized, is based on real-estate data that refer to, among other things, areas, construction, ownership, and kind of fuel used in the heating system. The system, used by some fifty municipalities, can be updated.

For oil substitution planning, inventories of potentials for using energy woods, peat, and wind power have been made by the Regional County Boards and the National Geological Survey.

Information from local authorities on electrical power supply and consumption is used for estimating energy balances. Oil supply statistics are made available by the delivery companies. The main shortages of information are on the consumption side, for heating as well as for transportation.

Strong efforts are being made to form appropriate information systems on the local and regional levels, making it possible to work out energy balances yearly or, at least, every third year.

3.2. *The Statistical System*

The collection and distribution of statistics, which form the basis of the regional information system, have been centrally organized by Statistics Sweden since 1960. Some important exceptions are statistics on unemployment (National Labor Board), roads (National Road Board), social insurance (National Insurance Board), and forestry (National Forestry Board).

Statistics Sweden is divided into three basic units, which work on individual statistics, spatial statistics, and economic statistics. Since 1975, there has been a special unit for regional statistics, having as its major task to coordinate the sectoral production units and to manage groups in contact with the regional and local authorities. These groups act as fora for marketing new statistics as well as surveying the demand for new statistics. Data for regional statistics are collected in basically two ways: by joint utilization of administrative data bases, and from population and housing censuses.

3.2.1. Administrative data bases

The National Registration System (RTB) is the data base for population statistics (Figure 4). It includes data on an individual's age, sex, nationality, civil status, and family relationship (e.g. number of children) for the whole population. The system is continuously updated with information on births, deaths, and migration. The registration is based on a real-estate unit. Regional and local statistics of this type are produced quarterly.

The income tax register is the data base for income statistics, which are produced yearly. Connection of this data base with the RTB allows statistics to be distributed by age, sex, and so on. The link is the so-called individual identification, which is a unique ten-digit number. Regional and local statistics are produced yearly.

The real-estate tax register includes data on type of building, area, taxation value, ownership category, and, in the latest version, building construction and fuel source (for energy planning). Taxation takes place every fifth year. Updating is performed only when the estate value is changed considerably. In the future, the taxation will probably be a continuous procedure, which will help to make the statistics more up to date.

There is another real-estate data base for legislative use. It contains mainly plans and stipulations, and ownership and other legal data. What makes this data base interesting is the grid registration, which, it is hoped, will be finished in the 1980s.

In addition, there is a central register on firms (CFR), which was built up in the seventies. The main variables are economic sector classification, number of employees, address, and (by connection to an address data

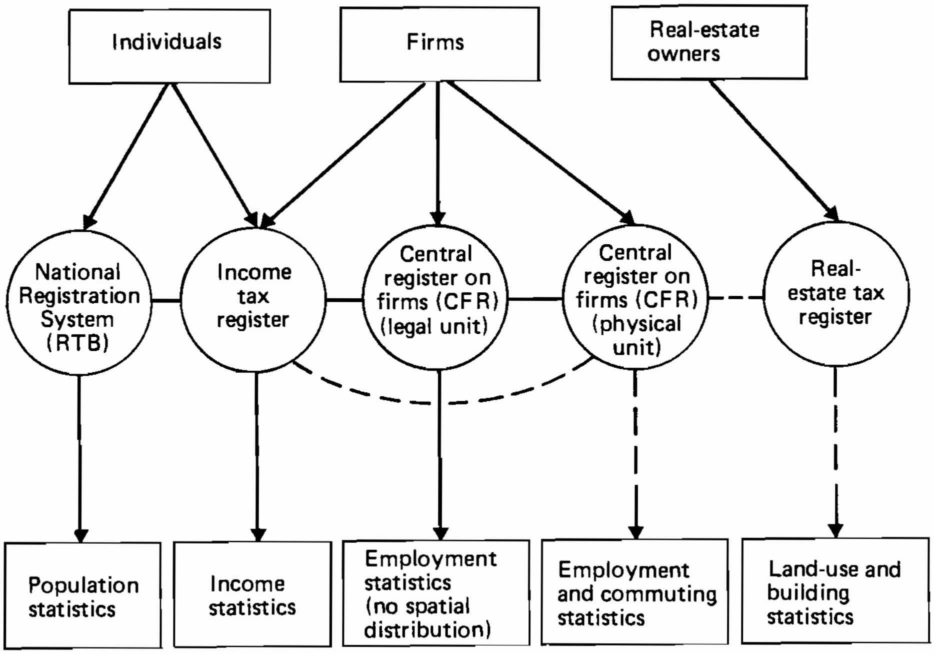

Figure 4 Administrative registers for production of regional statistics. A broken line indicates that a connection or production of statistics is not yet established.

base) real-estate unit. The register is divided into two parts, in which the basic units are, respectively, the firm as a legal entity (e.g. head offices) and the branch or work place (e.g. physical units). The data base includes both the public and private sectors. Identification is given by a so-called organization number (legal unit) combined with a unit number (physical unit).

3.2.2. Population and Housing Census

The administrative data bases are not yet sufficient to provide the information necessary for regional planning. The shortages of information on employment, households, and housing are compensated and/or completed by the Population and Housing Census. Originally an instrument for population registration, the census has developed into a basic survey for regional and local planning as well as sociological research.

Censuses have been carried out every fifth year since 1910. The questionnaire has changed over the years, and up to 1970 the content of the census had been increasing. A serious debate at that time about confidentiality and the unacceptable number of people who did not respond made it necessary to shorten the questionnaire in the 1975 and 1980 censuses.

The main components in the 1980 census referred to:

- employment level
- employment by economic and institutional sectors and by occupation
- commuting
- household composition
- housing stock, by house type, form of possession, owner category, age-structure size (number of rooms), and equipment standards (water supply, heating system).

Connections with the National Registration System make it possible to distribute all information according to age, sex, nationality, and civil status. An important feature of the census is that it makes it possible to compute the *informal* household composition. Civil status has been a poor measure of household composition since the 1960s in Sweden, because of the high number of people living together who are not formally married.

Another important feature of the census is that it offers possibilities of integrating information. Most important is the linkage between household groups and dwelling stock characteristics. There are also possibilities to link housing information to, for instance, income, occupation, and commuting variables.

The categories of respondents to the questionnaire are individuals (by employment, occupation, and position in household), real-estate owners (housing data), and companies (economic and institutional sectors). Local authorities collect and examine the information and connect individual and housing information. Connection with company information is made by Statistics Sweden.

The reliability of census data is normally high. The fraction of people who do not respond is about 1–2%. For single variables, evaluations have shown that the error might reach 3–4% for employment measurements. Variables describing occupation and dwelling size show errors of up to 15%.

The census results are presented in four different ways:

(a) aggregated tabulations in official statistical publications (10–15 volumes);
(b) "raw" tables, including detailed information distributed to local and regional planning authorities;
(c) magnetic tapes, containing exhaustive tables with detailed classifications on a detailed regional level;
(d) distribution through the Regional Statistics Data Base.

The main disadvantage of census data is that they are not sufficiently up to date, because of the five-year interval and the lag between collection and presentation. For example, the most recent housing data available in 1982 were the 1975 census results. This inadequacy has been stressed anxiously during recent years, resulting in great efforts to make it possible to provide census information by completing the administrative data bases. From 1985, it will be possible to achieve yearly regional and local employment statistics by connecting the individual register, the income tax register, and the central register on firms (physical units). A prerequisite is that the income tax register is completed with a physical employment unit.

To obtain yearly housing and household data, more radical changes have to be made:

(1) A dwelling-unit register has to be built up, and routines for updating must be organized.
(2) The register on individuals has to be changed in the sense that the dwelling unit will replace the real estate as the registration key.

In Denmark and Finland, these solutions are now being tested, and censuses are no longer carried out. Current plans in Sweden will make this solution possible no earlier than 1990.

3.2.3. *Other regional statistics*

The administrative data bases and Population and Housing Census are complemented by certain sector-oriented statistics. The most important are the following:

- a yearly industrial survey of production, investment, real capital, and energy use: the survey is exhaustive and covers all companies having more than five employees;
- monthly unemployment statistics, which are based on the administrative data base of the National Labor Board;
- the regional distribution of goods carried by trucks;
- monthly wage statistics, primarily used for wage negotiations, jointly collected by Statistics Sweden and the unions.

3.2.4. *Regional Statistics Data Base*

The heavily increasing production of regional statistics made it evident that the standard ways of presentation and distribution had to be changed. Refining official statistics for appropriate use in regional planning tends to be a long-winded and unnecessarily time-wasting part of the planning procedure.

Therefore, Statistics Sweden has developed the Regional Statistics Data Base (RSDB), a general-purpose system for distribution of statistics. The system makes it possible for the user to design tailor-made statistics within the framework of a large set of matrices, which are stored in the computer. The matrices are stored on the local level, making it possible to aggregate the data to commune and county levels. The matrices cover a broad field of statistics, including the census and register data mentioned previously.

4. Use of Information and Statistical Systems

It is difficult to make a distinction between use of information for planning and for modeling, because we regard a model as an integral part of an information system. Therefore, we divide this section into three parts: the use of information systems in a broad sense (e.g. models *and* statistics), the use of computerized information systems, and the use of statistics.

4.1. *Use of Information Systems*

Much of the current discussion among planners and decision makers in Sweden involves the use of modeling as a tool for planning and policy making. Breaks in trends of national economic development and regional development have meant that a lot of forecasts have failed. Models using the economic base principle of economic activities have not been able to explain the rapid growth of the service sector. Input–output models are evidently too complicated for use at the regional level in Sweden. Policy makers are quite sceptical about using analysis that they consider to have been worked out in a "mechanical" way. Planners and statisticians have produced a lot of documents mainly dealing with inventories and trend-based forecasts.

In the future, planning will have to involve a lot more qualitative analysis and discussions about consequences of alternative future developments. Forecasts will have to rely less on long-range projection of present trends. Planners will have to explain their prerequisites and assessments and be more flexible in making alternative forecasts and assessments in view of the dynamics and uncertainty in Swedish economic development.

A typical example of the current sceptical attitude is that the quality of the local medium-term economic planning system is being questioned and the system is nearly out of use. Economic uncertainty makes local planners find it more or less meaningless to draw up investment plans for a five-year period, when they do not know enough about future national policy and industrial development.

Another example is that the regional breakdowns of the Long-Term Survey are not really regarded seriously at the regional level – they are looked upon as too "mechanical."

This does not mean that we do not need models in regional planning. Rather, we need more flexible and more instructive models and planners.

4.2. *Use of Computerized Information Systems*

The regional development planning system, UMDAC, is frequently used by the County Boards. Three years ago, it was made accessible also to communes and national authorities. As the system is very powerful, and the interactive dialogue is very quick, its use is growing rapidly. To produce a table (or a forecast) takes at most five minutes. The user cost is about 30–50 Swedish kronen for a session that includes a forecast and some tables. The dialogue is keyword-oriented, which means that the training necessary to handle the system is a bit more comprehensive than for other more user-oriented systems.

The Regional Statistics Data Base is a typical highly user-oriented system. Being easy to handle for any planner or policy maker, it can also be a hindrance. The dialogue is "menu-oriented," that is, the system gives the user a set of alternatives on what to do next but the procedure tends to be tedious, and after using the system a couple of times the user finds it quite boring. Another disadvantage is that the system so far does not provide any unique information; the statistics are all to be found in publications. The potential users being the Regional County Boards, the UMDAC system has been a superior competitor of the RSDB system. Hence, the current efforts to improve the use of the RSDB are aimed at changing the spatial distribution from the commune/county level down to the key areas. This will make the system interesting also for local planning.

The national physical planning data bank is used very little so far, and mainly by the National Planning Board. Reducing the grid size from a 5 km square to a 500 m square will make the system interesting also for regional planners. In the long-term perspective, an integration of regional development planning with national physical planning will make it necessary to integrate the information systems as well.

4.3. *Use of Statistics*

Statistics traditionally play an important part in Swedish policy making and debate. Regional development planning has made statistics an important form of communication between local, regional, and national planners. The number of employees at Statistics Sweden has increased from 400 to 2,000 over the last twenty years. The demand for more and better statistics is still very heavy. The character of the demand, however, is changing gradually from the conventional standard cross-tabulations to analyzed statistics. The demands for analysis vary over a wide spectrum. More time series, graphic products, and interregional comparisons are some examples of the simple kinds of analysis demanded. More complicated analyses, such as regional forecasts of the occupational distribution of labor demand, analyses of regional fertility and mortality patterns, regional standard-of-living surveys, and remigration (ruralization) studies, are already carried out by Statistics Sweden.

However, these examples are unfortunately still exceptions to the main pattern of the production of statistics in Sweden. Most of the statistical products are still of the conventional kind. The statistical system is set up mainly to serve national planning and policy making. The national accounts are an important framework for the collection of data. The agriculture, housing, and industrial sectors are rich in statistics, while statistics on the service sectors, land use, and the environment are insufficient.

Out of the budget for Swedish statistics production (Skr 300 million) less than 10% is intended for regional statistics. Whether it will increase is partly dependent on the exhaustive statistical investigation now taking place. In this investigation, the demands for statistics within all sectors of society are being examined. The demands for regional statistics are being examined separately by one of four expert groups. The preliminary results from the investigation show that both local and regional planning offices want to produce their own statistics from data bases assembled by Statistics Sweden. Decentralized production of statistics was intensively discussed in the early seventies. At that time the prerequisites of computer hardware and systems knowhow appeared to be insufficient. However, the rapid development of microcomputers, combined with more competent personnel in the eighties, will probably lead to a *decentralization* of the final step in the production of statistics, namely tabulation and analysis. Collecting and examining data, as well as establishing standard definitions and integrating administrative data bases, will still be important tasks for Statistics Sweden.

5. Recommendations and Perspectives

The information systems at the regional level are not as integrated as many planners and decision makers would like. Further, long-term planning at the national level is not integrated with county planning and there are discrepancies between regional and local planning. It is not easy to solve these problems, but efforts to improve integration are proceeding.

One criticism of county planning has been that it deals too much with statistics and information. The critics say that county planning ought to deal with coordination of planning in different sectors and also with more concrete planning.

Changes have gradually been made over the years and today a County Board's regional policy responsibilities can be described as the promotion of regional development in various ways, which includes planning, the administration of regional policy measures, and the coordination of activities in particular sectors.

The main significance of the 1982 Regional Policy Act in this respect is that it decentralized the county planning system and made it less formal. Formerly, there were far-reaching planning rounds every five years and detailed instructions on how the planning should be carried out. County planning today is very much planning by each County Board for its own activities within the regional policy field.

An important change is that annual regional planning has replaced the earlier five-year plans, which were regarded as obsolete a short time after their presentation. They were to a large extent based on data from censuses.

One problem with the new planning system at the regional level is to provide it with information and statistics. A special investigation at

Statistics Sweden has looked into the possibilities of replacing census data arising from special enquiries by using administrative registers. At least it will then be possible to create better annual employment statistics at the regional level. This means that there will be a better fit between the statistical system and the information system, and between the information system and the planning system. It will perhaps also be easier to integrate the different systems. But it will, perhaps, not be enough.

As administrative registers are based on information from separate sources, there will be more problems with secrecy and integrity in the future. The information system will combine information from different sources. This is easy if the sources have the same standards and use common forms of identification, but the authorities responsible in matters of secrecy want the planners and statisticians to combine information to as small a degree as possible. In the future those who want to combine statistics from different data bases will have to prove that it is necessary and that the interests of individuals will be safeguarded.

6. Conclusion

The desire in Sweden is to have an information system at the regional level that:

(1) gives information about the regional consequences of development and planning at the national level;
(2) is coordinated with information systems at the local level;
(3) integrates information about both physical and economic conditions;
(4) is based on annual statistics or, at least, has a more frequent inflow of new information than each fifth year. This might mean that administrative registers will be used to a larger extent.

Reference

Thufvesson, B., and G. Svensson (1981) *Hur Planeras Sverige*? (Stockholm: Liber).

Bibliography

Canadian Cartographer (1977) Computer cartography in Sweden. Vol. 14, no. 20.
Falk, T. (1976) *Urban Sweden* (Stockholm: Liber).
Habitat 76 (1976) Plan no. 1–2/1976. *National Report* presented at UN Conference on the Human Habitat, Vancouver, Plan International.
Hagerstrand, T. (1977) On regional policy in Sweden. *Report* 39/1977, University of Lund, Lund, Sweden.
Hårsman, B. (1981) Housing demand models and housing market models for regional and local planning. *Report* D13:1981, Swedish Council for Building Research, Stockholm.

Hårsman, B., *et al.* (1980) Housing policy and housing market analysis. *Report* D16:1980, Swedish Council for Building Research, Stockholm.

Hottovy, T. (ed.) (1980) Future studies in Sweden on building and planning. *Report* D38:1980, Swedish Council for Building Research, Stockholm.

Ministry of Industry (1982) *Swedish Regional Policy 1982.*

Nordbeck, L. (1980) RSDB, a system for interactive access to a statistical data base. *Report* DBM 1980:3, Statistics Sweden, Stockholm.

Statistics Sweden (1981) Regionalization of statistical activities. *Paper* prepared for Commission of European Statisticians Meeting, Moscow, September.

Thelander, H. (1981) Experience with the Swedish regional data base. *Report*, Statistics Sweden, Stockholm.

Thufvesson, B., and G. Svensson (1975) *Planning Sweden* (Stockholm: Liber).

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CHAPTER 20

Information Systems for Integrated Regional Planning and Policy Making in France

Jean Muguet

1. Regional Planning and Policy Making

Planning and policy making in France have been highly centralized for a long time. Indeed, centralization has been a great support in the growth and strengthening of the nation. However, many people consider that the process went too far, in that the location of all decision powers in Paris hampered local initiatives. The new decentralization law of 1981 aims at reversing this process and reinforcing the role of local authorities: regions, departments, and communes. The design is broad, and will not be fulfilled for several years, but the turn has been taken and its consequences will be important to the nation.

Planning in the French way, based upon dialogue and agreement, must reflect the power structure in order to be efficient. Although the planning process used to be centralized, the 9th Plan (1984–88) will modify this greatly.

1.1. *Regional Planning, 1945–81*

The first French plans did not mention regional problems. Economic regions were created by the decrees of 30 June 1955, whose object was to complete the national Modernization and Equipment Plan by coordinating public and private resources in a regional framework. They prescribed the establishment of "regional action programs" to be integrated in regional economic development plans.

Regional plans became effective with the 4th Plan (1962–65), whose implementation through "operative installments" involved the timing of operations, priorities, and indications about financial planning. The two main public agencies were created in 1963: the Commissariat Général du Plan, CGP (General Planning Agency), and the Délégation à l'Aménagement du Territoire, DATAR; both are still the Parisian backbone of regional planning. The 5th Plan went further, by integrating regional concerns in the national plan and creating regional installments of public investment, analogous to operative installments. They were distributed in three categories:

(1) investments at a national level, e.g. highways and universities;
(2) investments to be specified at a regional level, e.g. collective dwellings, high schools, and agricultural projects. Priorities are chosen by the Préfet de Région, who represents the central government;
(3) departmental investments, e.g. primary schools. The Préfet distributes program authorizations and payment credits between the departments of his region.

During the 6th Plan (1970–75), the focus was no longer regionalization of the plan, but regional planning, and even urban and regional planning. The main purpose was to limit the growth of the Paris region, by developing the metropolitan region, balancing the urban hierarchy, and restructuring rural areas around big towns. It should be emphasized here that politicians were backing decentralization at that time, after General de Gaulle's Lyons speech in 1968 and the preparation of a referendum in April 1968 on this topic. This explains the relatively autonomous character of regional approaches compared with the national plan. It was the era of great studies: regional scenarios, exploring economic perspectives until 1985, "white books" (scenarios) on metropolitan areas, sketches of urban planning up to 2000, and urban perspective surveys. Public investments were split into four categories: the first one was committed to national goals and, as such, was under the control of central government; the fourth one was directed to local goals and was under the control of departments and communes; the intermediate categories contributed simultaneously to the fulfillment of the goals of local and regional authorities.

The necessary discussions took place at two levels. At the national level, the General Planning Agency (Regional and Urban Division) and DATAR checked the consistency between medium-term regional economic perspectives and long-term plans for land use, and distributed public investment credits under total or partial government control. At the regional level, the corresponding job was performed by the Missions Economiques Régionales. Subordinate to the Préfets, they had to program and implement public investments under regional or local control, and to lead discussions with planners and technical experts about the future of regions.

This organization still prevailed during the 7th Plan, but many obstacles had accumulated and the plan was losing its direction. The discussions at every level were heavy, and the harmonization of the various programs resembled more compromise than full approval of plans. The very concept of growth was reflected upon. Economic crises and the boom in oil prices had upset all previous predictions. It became no longer possible to base a national plan on the index of growth of gross national product. Therefore, the aims became less ambitious and were limited to a series of partial objectives of national or regional interest, realized through "prior action programs." This tendency increased during the preparation of the 8th Plan.

The regions and departments of France are shown in Figure 1.

1.2. *New Planning and the Role of the Region*

The planning reformation law (29 July 1982) commits regions to a basic planning role. According to this law, there will be a national plan and regional plans at the same time. As the region becomes a political entity, it will participate in the planning process at various levels.

1.2.1. Lawful participation in the National Planning Commission

For the first time in history, local authorities will be systematically represented in the National Planning Commission. This Commission, which has a consultative voice, is in charge of leading the necessary consultations for elaborating the national plan and taking part in its execution. Besides regional governments, trade unions, employers' unions, representatives of cooperatives, and mutual assistance societies, cultural groups will be members of the Commission.

1.2.2. Contribution to the national plan

Regions had to make proposals about the main orientations of the national plan of July 1982. The central government synthesized them in a report, which was transmitted to the National Planning Commission and to the regions. The whole process gave birth to a bill, in the spring of 1983, about the strategic choices and goals of the 9th Plan. The corresponding resources will be defined in a second law, which should be ready four months before the beginning of the 9th Plan.

1.2.3. Elaboration of regional plans

An elected executive body, the Regional Council, will reinforce the powers of the region. The region will be free to elaborate the regional plan in its own way, under the only condition that it consults departmental authorities and socioeconomic partners. Regional plans should focus upon two kinds of proposals. The first kind concerns development of production sectors: agriculture, industry, and services. The demand for public facilities should be considered as subsidiary to the region's own efforts in favor of production activities. The second kind of proposal refers to education and skill training.

Figure 1 French regions and departments.

1.2.4. Connection of national and regional plans: Planning contracts

Consistency between various planning levels will be secured by means of contracts, which will deal with both national and regional strategic goals. They will express either national support of regional schemes of industrialization or skill training, or regional support of national policies (policy on mountainous regions, maintenance of poor zones, aid to minorities). Each planning level will finance programs within its own legislative and institutional competence.

From the institutional point of view, DATAR, at the national level, is in charge of coordinating the various regional plans and of fostering the exchange of information and experiences between central and regional authorities. Inside a region, the Préfet, now to be called the Commissaire de la République, is the only representative of the state who is allowed to elaborate, sign, and follow up planning contracts.

1.2.5. Association of regional plans with local agents

A region should prepare other contracts on its own initiative:

- with departments (public facilities, housing, and physical planning);
- with separate communes or groups of cities (creation of employment areas, setting up of communal development charters, land-use planning);
- with other regions, about programs of mutual interest;
- with public and private companies in the production sector that are located on its territory;
- with the banking system: it will prove necessary to evaluate the financial needs associated with the execution of regional plans and to prepare the instruments, warrants, or subsidized loans.

The new plan, as defined by the law of 29 July 1982, is intended to differ basically from previous plans, to which information systems had to adapt year after year. Will the new needs be met, and will the information flows and elaboration be adapted? One should hope so, but the task is not easy.

2. Regional Information Systems

2.1. *Regional Features of Information Systems*

Prevailing information systems reflect the structure of political power. Therefore, as one would expect, they are mostly centralized. For the sake of presentation, we shall refer to the analysis scheme proposed in Chapter 18 by Nijkamp and Rietveld. The various elements of French regional information systems are indicated in Table 1.

2.2. *Collection of Data*

The main information sources are national data repertories, censuses, and surveys. Secondary sources are administrative registers, whose extension would develop both the quantity and quality of regional and local statistics. Finally, there are sampling surveys, their validity depending more or less on the size of the sample or the geographic level of analysis.

Table 1 Analysis of French regional information systems.

Planning component	Institution involved	Geographic level
Spatial		
Multiregional	CGP, DATAR	Regions, departments
Regional and local	Regional councils, Commissaires de la République	Local areas, urban districts, urban systems
Sectoral		
Population, households	INSEE	Blocks of buildings, cities, rural areas, urban districts, cantons, arrondissements, departments, regions
Health, welfare	Ministry of Social Affairs and National Solidarity	Regions, departments
Culture	Ministry of Culture	Cities, cultural centers
Education	Ministry of Education and Professional Training	Académies, departments, schools, colleges, universities
Tourism	Ministry of Leisure	Regions, tourist areas, departments, cities
Environment	Ministry of Environment	Sensitive areas
Justice	Ministry of Justice	Departments, law courts
Employment and labor markets	Ministry of Social Affairs and Labor	Regions, departments, cities, labor areas
Income and consumption	INSEE	ZEAT (large regions)
Companies (repertories and data bases)	INSEE	Individual repertories, including addresses
Agriculture	Ministry of Agriculture	Rural areas, departments, cities
Industry	Ministry of Research and Industry	Regions, departments, chambers of commerce
Commerce	Ministry of Commerce and Handicraft	Regions, departments, chambers of commerce
Dwellings	Ministry of Urbanization and Housing	Regions, departments, urban districts, rural areas
Infrastructure	Ministry of Urbanization and Housing	Regions, departments
Transportation	Ministry of Transport	Regions, departments
Foreign trade	Ministry of Economy and Finance (customs)	Regions, departments, ports
Migration	INSEE	Regions, urban and rural areas

2.2.1. National sources

(a) The most recent General Census of Population and Housing was in 1982. Earlier ones were in 1946, 1954, 1962, 1968, and 1975. Collection of data is the responsibility of the town governments, which recruit interviewers to meet people at home. The whole process is controlled by the Institut National de la Statistique et des Etudes Economiques (INSEE), which gathers the questionnaires for processing.

(b) Environmental inventories are made of water and air pollution, endangered species, land use, and industrial waste. Information is obtained by observation and interviews.

(c) Information is available from repertories on enterprises and establishments (Système d'Identification pour le Répertoire des Entreprises et Etablissements, SIRENE), and from the General Census of Agriculture, for which exhaustive surveys were made, by means of interviews, in 1970–71 and 1979–80.

2.2.2. Administrative formularies

(a) Records of births, deaths, marriages, and divorces, by place of registration and place of residence.

(b) Records of health, medical, and social care, e.g. from social welfare programs (since 1963), medical establishments, and professions in social services.

(c) Education records, based on the collection and processing of formularies according to level of education and school year (September to June).

(d) Justice records, including annually processed data about divorces or law sentences, and various forms filled in by courts or management documents.

(e) Employment records comprise documents issued by the National Employment Agency, the Departmental Direction of Labor, and the National Immigration Office. The documents are usually compiled monthly or quarterly.

(f) Incomes records consist of fiscal declarations about salaries and of social security sheets. They are processed annually by INSEE.

(g) Housing records include statistics on building licenses and on the rent aid program.

(h) Transportation records comprise registrations of vehicles.

(i) Records of foreign trade are created from monthly processed customs declarations.

2.2.3. Sample surveys

A great many sample surveys of various kinds are carried out in nearly all sectors. They are particularly useful for filling the gaps in information from public formularies, and for providing additional information to meet the needs of sectoral planning.

(a) *Population and households*. Apart from carrying out monthly surveys of retail prices, INSEE makes comparisons of standards of living between large conurbations (1972, 1977, 1978). Also, there are periodic surveys of living conditions in households, or of intentions to purchase households.

(b) *Health*. Most often, surveys are done by mail and focus on health-care establishments.

(c) *Employment*. There are quarterly mail surveys of work activities and conditions (Ministry of Labor).

(d) *Incomes*. INSEE carries out biannual surveys on salary costs and surveys every six years on the structure of salaries. These surveys are made through the mail. There is also a five-yearly survey of fiscal incomes of households, which is made by studying a sample of fiscal declarations.

(e) *Agriculture*. There are many surveys of harvests, technologies, structures of farms, and financial variables.

(f) *Industry, trade, and services*. Every year there is a mail survey of enterprises, which is exhaustive for the biggest firms but samples the others. In addition, monthly surveys of production or commercial activity are made by mail or telephone.

(g) *Transportation*. Surveys are made annually of the use of road transport vehicles and (since 1971) of interregional flows of goods by road, rail, air, or water.

2.3. *Contents and Quality of Information*

2.3.1. Stocks and flows

The consistency of the French statistical system is secured through national accounting, the main concepts of which are flows and exchange values. Therefore, most of the regional data on production and trade reflect the exchanges that have occurred in the period considered: purchases and sales of goods and services, and distributed, spent, or saved incomes. Thus, one may know the investments of industrial firms but not their production capacities; and one estimates the income of households, but not their wealth.

However, the actual situation differs from this in two respects. Firstly, the population is well known around the census years, but its actual condition is better known than its evolution, particularly the migratory component, which all indicators fail to measure accurately. Secondly, all the inventories of land, natural resources, environment, and companies and establishments provide information on dummy variables, and can be considered as qualitative data. The only exception is public infrastructure, which is known from annual installments in the government accounts.

2.3.2. Main gaps in regional information

Users acknowledge that public information is plentiful, though hardly accessible at regional or local levels. There are several reasons for this. One is that, because regional data are quite often produced by analyzing national figures, there is often a delay before the regional data become available. Moreover, sampling methods seldom use the region as a criterion for stratification, so that random errors can be significant for small regions. Short time series (10 to 15 years) also hamper econometric studies.

A confidentiality rule prohibits the publication of too much detail on small areas. By this rule, published information must cover at least three economic agents, none of which represents more than 85% of the variable under consideration.

Another reason for inadequate regional information is the shortage of tools for synthesizing and coordinating this information, such as economic accounts. For example, the labor force can be measured using many sources, but all are partial.

Finally, knowledge of interregional flows of population and goods is poor because of the priority given to the links between region and nation rather than to interactions between regions.

2.4. *Information Technology*

The progressive use of computers since the sixties has deeply modified statistical information processing. Apart from calculations, computers are being introduced more and more for operations in other areas of statistics.

(a) *Data collection*. This is not computerized yet.

(b) *Coding and data entry*. Coding and data entry have become inseparable, being done on-line from field formularies. Two techniques are used: connection to a central computer by special software, and mass entry on minicomputers in each region.

(c) *Statistical processing*. This is done on big central computers, using standardized softwares dedicated to list or array editing and file matching. Repertories are held by national centers in Nantes and Toulouse. Strictly regional computations are most often processed in remote-batch operations.

(d) *Data storage*. Once copied on to magnetic tapes, statistical data are stored in national computing centers. There are some regional tape libraries. Access is made by teleprocessing and with special softwares for automatic documentation (Sphinx) or array calculation (Cactus).

(e) *Distribution of information*. As experience shows, regional or local information users are repelled by "raw" figures, listings, or arrays. Comments and illustrations prove necessary. Therefore, most data-producing administrations publish their own regional statistics bulletin or yearbook (e.g. INSEE issues documents on labor, agriculture, industry, and the central bank). Regional data banks are just developing, probably because of the lack of decision makers outside the capital city.

3. Use of Information Systems

In this section we will differentiate between two kinds of users of information systems: regional planners, who use statistical data in preparing their decisions, and services that build models of the reality they are studying. The distinction is not absolute, for many models, in a direct or indirect way, influence the decisions of planners. However, we will make the distinction for the sake of clarity.

3.1. *Information Systems for Regional Planning*

Public statistical data are, in principle, accessible to every citizen in France at all levels of planning, national, regional, or local. So far, however, the interest taken in the last level has been considerably deeper.

3.1.1. Three levels of regional planning

(a) *Regional–national or multiregional planning* answers to the problems of the central authority in charge of territorial planning. The key word here is (geographic) distribution: of production, wealth, infrastructure, and people. The main constraint is that of consistency: one must find the national value of a variable by summing its geographic components.

The 6th Plan is a good example of this procedure. At the beginning of the regional work, a regional scenario was elaborated in 1968; it estimated total population, labor force, employment, and interregional migration up to 1985. The spatial framework consisted of seven great areas, called zones d'études et d'aménagement du territoire (ZEAT), each centered upon a cluster of activities or "equilibrium metropolis": Lyons–Saint-Etienne, Marseilles, Metz–Nancy, Strasbourg, Nord–Pas-de-Calais, Basse-Seine, and Basse-Loire. The statistical material, used at this stage, was composed of projections of population and labor (supplied by INSEE), employment series, by region and sector, and figures for interregional migrations, with explanatory models.

Public investments were distributed among regions according to two equalizing criteria: the number of job conversions in declining branches of industry and the number of jobs being created. Each region included an equilibrium metropolis, whose development had to be fostered. Once calculated, the corresponding investments were submitted for approval to the central government, which brought only few modifications.

During the 7th Plan, the method stayed similar. The main variables under consideration were population, employment, and public investments. Regional accounts of households and enterprises were not used, because the five-year delay in their availability looked excessive.

(b) *Local–regional planning*. The lack of political structure at the level of the administrative region used to be the main obstacle to the development of regional planning. The few global statistical tools were elaborated by university teachers in Lorraine and in Loir-et-Cher.

In 1965, the Préfets had to write on the long-term development of regions, in the following fields: demography, planning in rural areas, the urban hierarchy, the communications network, and water policy. Though they referred to data and studies, after long discussions with social experts the reports usually showed general plans without quantifying objectives and means. Most of these plans are still available and serve as a basis to the regions' responses to government proposals.

(c) *Local (subregional) planning* refers to areas of daily life, including housing, places of work, and commercial centers. For big cities local planning encompasses the whole conurbation. The process that led to the 6th Plan consisted of two separate phases. Firstly, the Urban Perspective Group concentrated on the infrastructural needs of cities, the consumption of space, and social indicators of "urban harmony or discord." On the other hand, the agencies of the Organization Régionale d'Etudes d'Aires Métropolitaines (OREAM) were in charge of preparing "white books," inventories of the strengths and weaknesses of urban areas, and proposed a land-use scheme consistent with a sketch of demographic and economic development.

During formation of the 7th Plan, the idea emerged of making contracts between middle-sized towns and the government (contrats de pays). The intention was that they should lead to integrated programming of public investments (national, regional, and local) to reach precise goals of local development.

3.1.2. What kind of information?

The Censuses of Population and Housing still remain the only source of information available at every planning level. The basic geographic unit is the town, or the quarter in cities.

To meet demand, INSEE has been developing communal data bases for a few years; most of their content originates from censuses and records of births and deaths. In addition, more repertories of establishments are being set up at the regional level: they include such variables as addresses, activities, and the annual number of workers; accounting data on production, purchases, and salaries will be added.

Economic accounts could be powerful tools for planning. The first systematic accounts were published in 1972 for the 21 regions; they dealt with households (1962–67 series), communes, and the agricultural sector. Regional production accounts have been computed since 1970. They are now published regularly, but the mean delay of five years strongly reduces their interest for regional planners and decision makers.

A growing concern for regional accounting is shown by the European Economic Community, which uses economic aggregates for preparing its regional policy and the distribution of funds in favor of depressed areas. The most common indicators are gross regional product per capita and disposable income per capita, at regional and departmental levels.

According to decision makers who live and work in regions, the deficiencies of the public information system are numerous. First of all, the delay makes the data unsuitable for use, because they do not include recent events that affect regional development – opening or closing of factories, for instance. As to the 9th Plan, local planning agencies will have their own budget, and are expected to rationalize their decisions and to make sure of their social and economic efficiency. Apart from population and employment data, the framework for preparing and implementing regional plans is unrealistic in practice. Hence a second criticism, perhaps more fundamental, bears upon the philosophy of data processing. Even though questionnaires are completed by local economic agents, households, or companies, one has to wait until all national data are checked before starting regional tabulations. Some attempts are being made to avoid this constraint and to use partial and provisional data tapes, to program regional or local "instrument boards."

3.2. *Information Systems for Modeling*

The development of regional planning models in France is strongly influenced by the available information and by the demand from planners.

3.2.1. Demographic models

Demographic models are commonly used at all levels. We shall mention two of them. The PRUDENT model provides perspectives of total population, labor force, school-age children, and household heads according to sex and age. This model works in any zoning system, predetermined through a list of communes. It exists in two versions: one extrapolates past trends, while the other, variational version is based on exogenous modifications to demographic behavior variables and works as a simulation model.

The MIGRAGE model tries to forecast migrations by year and age in any zoning system. Basic data are age pyramids from the previous censuses, as well as age distributions of births and deaths. It allows an accurate analysis of local needs, with respect to schools or retirements for instance.

3.2.2. Multiregional models

A good example of a multiregional model is REGINA, designed by Professor R.A. Courbis to meet the needs of the 6th Plan (see also Chapter 11). It is based upon the first researches in regionalizing input–output tables. The regional unit used is the ZEAT. REGINA is a national–regional model that deals simultaneously with all areas and thus perfectly answers to the problems of DATAR and central decision makers in regional planning. It introduces production, income, and consumption variables (in both volume and value) and forecasts interregional flows of goods. However, to some extent its broad scope and its dependence on complex processes, together with the use of areas that are too large, have hampered its use by strictly local decision makers in regions and departments.

3.2.3. Local socioeconomic models

To meet the needs of decentralized planners for the 7th Plan, INSEE devised a regional simulation model (SDR). The model has a flexible structure that can be adapted to local peculiarities, and a standardized data base. The purpose of the model is to investigate problems of unemployment and education by matching two submodels focused on demographic evolution and on economic change and labor demand. The results were migration and unemployment projections for the various planning areas. The model was designed to work on the basis of different planning hypotheses, national, regional, or local (impact studies).

Besides SDR, which provided regions with a common instrument, specific models were built, such as for Marseilles and Lille. The econometric model built for the Provence–Alpes–Côte d'Azur region concentrates on the evolution of industrial activities, split into traditional and dominating sectors, and estimates the impacts or multiplication effects of exogenous variations in employment. For the Nord region, stress is put on the spatial distribution in the 14 considered labor market areas; forecast variables for total population, potential labor force, employment, and unemployment are estimated with an evolution model that works on one-year age groups.

Even though their use by policy makers was not frequent, these models did contribute to yielding insights into local economic systems, and to accumulating all available data in an analytic, coordinated framework, thus providing spatial time series.

4. Recommendations and Perspectives

The preliminary phase of the 9th Plan has led to serious thought about the regional information system by the National Statistics Council and the National Planning Agency.

4.1. *The Priorities*

The "decentralized economic and social information" working group of the Commissariat Général du Plan isolated two priorities in its report of April 1982. These will now be described.

4.1.1. Promote access to information

Rich and abundant information already exists but its use is usually limited to the public administrations that produce it, and they cannot afford to analyze or publish their data. The proposed actions are, therefore, as follows.

- Increase the usefulness of existing data by creating a communal data bank and decentralizing the public statistical offices.
- Review rules and practices relating to the confidentiality of data collected, which hamper quantitative analysis of problems in small areas; the alleviation of the law about privacy of employment variables is an almost unanimous wish.
- Allow planners to consult data files in public organizations; every local authority should have the right of access to any statistical information about its own activities.
- Strengthen the regional and local means for promoting and developing access to information.

4.1.2. Fill some information gaps

Several actions at the different planning levels need priority to complete the following gaps in the information system.

Regional level

- more detailed economic accounts, especially for state and local governments
- medium-term economic perspectives
- quickly determined indicators of annual activities.

Departmental level

- public expenditures, in a functional analysis
- labor market, by educational level and profession
- incomes, for the various social groups
- public employment.

Subregional level

- follow-up data on employment and labor markets
- demography of establishments
- annual estimations of potential labor force
- local indicators.

Communal level

- thorough processing of the Census of Population and Housing, upon request
- annual estimations of total population
- demography of establishments
- degree of satisfaction with public infrastructure.

4.2. *Perspectives*

Many new activities are being developed:

(a) In the field of data collection, improvements are expected in the knowledge of employment at local levels: jobs in public services, changes in labor, and conditions of work; the "local data bank" has become an official project.

(b) In the field of aggregated data and models, environmental "instrument boards" will be formed in two departments in 1985.

(c) Statistical bureaus will be created in big cities.

(d) Information at the regional level will be coordinated by organizations similar to the National Statistics Council.

Bibliography

Regional Planning and Territory Management

Aménagement du Territoire et Développement Régional (Grenoble: Institut d'Etudes Politiques), 6 vols.

Commission de Réforme de la Planification (1982) Rapport portant premières conclusions de la réforme de la planification, March.

Regional Information Systems

Commissariat Général du Plan (1982) Rapport d'étape du groupe Information Economique et Sociale Décentralisée, April.

Conseil National de la Statistique: Rapports du groupe Coordination des Statistiques Régionales et Locales.

Conseil National de la Statistique: Sources statistiques d'intérêt régional et local. Essai d'inventaire, 1979.

Revue d'Economie Régionale et Urbaine (1980) Information et modélisation (vol. 4, nos. 2 and 3).

Information Systems for Integrated Regional Planning
P. Nijkamp and P. Rietveld (editors)
Elsevier Science Publishers B.V. (North-Holland)

CHAPTER 21

Information Systems for Integrated Regional Planning and Policy Making in the United States

Daniel H. Garnick

1. Introduction

In the federal system of the United States, despite a number of federal–state cooperative programs, no single agency or level of government has overall responsibility for regional development policy or related statistical programs. About thirty-four agencies in the federal statistical system are involved in the production of regional data series. (In addition, at the state and local levels a variety of statistical programs are under the aegis of diverse state and local government agencies and nonprofit institutions, usually connected with a state university.) Most of these are administrative agencies whose major purpose is to administer tax, regulatory, or income transfer programs rather than to produce general-purpose statistics. The administrative records collected by these and other administrative agencies, however, are a principal source of data for the several federal general-purpose statistical agencies as well as for the federal policy agencies. (Similar statements could be made for the state and local government levels.)

Regional planning in the US is similarly decentralized in terms of both sectoral components and spatial hierarchical components. Some movement toward greater coordination sectorally and spatially occurred throughout the 1960s and 1970s, only to be halted or reversed in the 1980s thus far.

At the national level, the Bureau of Economic Analysis (BEA) produces national income and product accounts (NIPA) and related tables and measures, which provide a consistent framework for interrelating the diverse economic data sources and for illuminating economic policy issues. Although no such relatively integrated economic framework yet exists at the subnational level, the Bureau has a major operational program of regional economic information and modeling that has had a substantial measure of application in many parts of the federal system. This chapter will focus on the program and its applications as a point of comparison between the US experience and the reference integrated regional development information system proposed in Chapter 18 by Nijkamp and Rietveld. Other complementary information sources will be identified, and their dissemination and problems of access will be noted.

2. Regional Planning and Policy Making

Early US federal regional development programs, dating from the 1930s, tended to focus on narrowly defined problems and to be administered by limited-purpose agencies such as the Tennessee Valley Authority. By the 1960s, multipurpose programs that required interagency coordination led to the establishment of special commissions, councils, or executive administrations. As an example, the Water Resources Council was established to oversee the programs for water and related land resources of member agencies such as the US Army Corps of Engineers, the Bureau of Reclamation of the Department of the Interior, and the Soil Conservation Service of the Department of Agriculture. Increasingly, related programs were grouped together in new departments and agencies, such as the Department of Transportation, the Department of Housing and Urban Development, the Environmental Protection Agency, and the Department of Energy.

In 1965, the Economic Development Administration in the Department of Commerce was established to stimulate strategic economic development planning at the local level, to subsidize public facilities to assist economic development in distressed areas, and to provide aid to local areas undergoing sudden economic dislocation. To complement the localized focus of the Economic Development Administration, the Appalachian Regional Commission and regional commissions of the Department of Commerce (comprising groups of states or parts of states) were established mainly to prepare multistate regional development plans. These agencies also were enjoined to coordinate with other agencies in related programs. For example, the President's Economic Adjustment Committee, consisting of the Economic Development Administration, the Department of Defense, and the Department of Labor, was established to investigate and respond jointly to problems of regional economic adjustment resulting from closure of major military bases. In the early 1960s, systematic regional data, and analytic frameworks for their application, were inadequate to support regional planning. Consequently, advocates of particular projects tended to exaggerate benefits and discount costs. To guard against this, in 1964 the Water Resources Council asked the Bureau of Economic Analysis to help establish a regional economic data base and a consistent set of regional economic and demographic projections. Subsequently, the

Bureau further developed its multiregional modeling capability and undertook regional analyses of programs for each of the above-named agencies and others.

It is difficult to identify the most important policy issues in regional planning of relevance to the demand for information. These issues are currently subject to changing tides in the US national consensus. The US, as well as other industrialized and, indeed, developing countries, is undergoing rapid and bewildering change in its industrial structure, and the regional dislocations stemming therefrom vary widely from state to state and among local areas. The US shares fully in the major issues facing most of the world with respect to regenerating economic growth, controlling inflation, reducing unemployment, and making the necessary adjustments to technological change and to the sharply changing terms of trade among sectors, regions, and nations. Where the US may differ most from other industrial nations is in the size and complexity of its federal system. Much of the administrative, tax, and political powers are reserved to the 50 states, and the local independence of its 3,000 counties and 19,000 municipalities varies substantially from state to state in providing public services and in tax authority. (The OECD (1980) has reviewed US regional planning policy issues, and the Advisory Commission on Intergovernmental Relations (1981) has reviewed differences from and similarities with other industrial nations.)

Public disappointment with the results of the "Great Society" programs of the 1960s and increasing public awareness of the limits of economic resources to implement these and related programs have led to a retrenchment in programs and to an emerging turning point in federalism in the US. The regional commissions of the Department of Commerce have been eliminated and the operations of the Economic Development Administration and Appalachian Regional Commission have been sharply curtailed. The present administration is determined to reverse federal ascendancy in providing and funding public services and to reserve these functions for the states. It is currently negotiating with the states for a new balance in sharing federal/state revenue and in responsibility for social programs. Inasmuch as disparities in per capita personal income among states have decreased over the long term and apparently are continuing to do so (Garnick and Friedenberg 1982), the administration takes the position that the states are more equal to the tasks entailed by reduced federal intervention. In particular, it maintains that lagging local areas can be helped more effectively by vigorous national economic growth than by *ad hoc* federal intervention (although it has put forward a limited program of "enterprise zones," wherein economic development would be encouraged through tax and regulatory relief).

While there is no explicit regional bias in federal tax and expenditure policies, some argue that the states are growing less – not more – equal to the tasks entailed by reduced federal intervention. One reason is that, because of sectoral shifts in interstate terms of trade and industrial differences in the ability to shift the incidence of taxes, interstate variation in resource endowments and severance tax policies gives some states greater potential tax capacity than others (Advisory Commission on Intergovernmental Relations 1982). Secondly, the pattern of federal expenditures and tax rescissions introduced by the present administration is likely to benefit most those states and local areas that already have advantages in economic growth, and to adversely affect most those states and areas that are already handicapped in economic growth (Muller 1982). Moreover, it is argued that those states and areas that gain from the first advantage tend to be the same as those that benefit by the second.

More fundamentally, some argue that the US should not have a federal regional policy at all, because it would be counterproductive on two grounds. Firstly, because the sharp falloff in productivity growth since 1973 cannot be ascribed to one or a few major sources (Denison 1979), policy to reverse the falloff must be directed to a large number of issues at the national level, each with small effect. Secondly, regional policy could be inconsistent with the requirements of a federal sectoral policy to cope with rapid technological change and shifting terms of trade internationally (Schwartz and Choate 1980). In essence, the issue is whether objectives of regional policy should be pursued at the cost of national economic efficiency. Indeed, it can be asked whether the objectives of regional policy are sufficiently well specified that even a comprehensive information system could measure adequately the trade-offs with or increments to the national efficiency objective. In this respect the US, despite its prevailing decentralism, probably finds itself in circumstances similar to those of West European nations (Ashcroft 1980).

This is not to suggest that regional and sectoral planning do not continue, however. Although not nearly as centralized as France, or even the Netherlands and Sweden, planning does occur in the federal agencies responsible for infrastructural development and maintenance, such as roads and public transportation in the Department of Transportation and housing in the Department of Housing and Urban Development. And, of course, infrastructure, energy, pollution control, and manpower training programs are maintained at the state and local government levels with the aid of federal agencies charged with these responsibilities. No regular time horizon prevails, however, in correspondence with the decentralization of sectoral and spatial planning functions. Water resources planning has the longest time horizon – up to fifty years – while other planning components such as bridges, roads, hospitals, and public housing also tend to have long horizons.

3. Regional Information Systems

As noted in the introduction, the discussion of regional information systems will center on that of the Bureau of Economic Analysis, with complementary discussions made for other statistical agencies. Considering the volume and importance of the statistics it produces, the BEA is a small agency. It employs approximately 400 persons and has an annual budget of about $18 million, in contrast to 6,000 persons and $100 million for the Bureau of Labor Statistics and 4,000 persons and $120 million for the Census Bureau (not including expenditures on the decennial population census). The relative sizes of these three agencies stem from their different mandates. The Census Bureau and the Bureau of Labor Statistics mainly generate source data, while the BEA largely constructs its national income and product accounts and related measures from thousands of statistical series generated elsewhere. Because of its size and limited budget the BEA has tended to operate with only the minimum necessary computer capabilities and user services. It has operated under the philosophy, common among federal statistics agencies, that the user community will develop its own dissemination and support systems, although it has undertaken a program of improvements of its data and software dissemination.

The Regional Economic Information System (REIS) of the BEA was developed in the late 1960s, initially to provide centralized data distribution and other user services and charge for them. As the demand for state and county personal income statistics increased, it became necessary for the BEA to establish a User Group, which in effect serves as a network of regional offices for user services. Each member of the User Group receives BEA data free of charge and, in turn, disseminates the information, through a wide variety of mechanisms, to others within its state. This system appears to meet the needs of most state and local government agencies. The REIS, however, continues to be the primary source for other federal agencies and private organizations interested in a national set of state and local personal income estimates.

The Regional Economic Information System includes an active information retrieval service, which provides a variety of standard and specialized analytic tabulations for counties and specified combinations of counties. All of the tabulations are available in the forms of magnetic tape, microfiche, and computer printout. The REIS data base currently includes the following data sets.

Quarterly state personal income. These estimates, available approximately four months after the close of the subject quarter, are published regularly in the January, April, July, and October issues of the *Survey of Current Business*. Since January 1983, quarterly estimates from the first quarter of 1948 through the third quarter of 1982 have been available.

Annual state personal income. Annual estimates for states are published twice each year. Preliminary estimates of total and per capita personal income, derived from the quarterly estimates, are published in the April issue of the *Survey* (four months after the close of the subject year). A revised set of estimates, based on more complete data and therefore more reliable, is presented in greater detail in the August issue. However, in 1981 the state estimates were presented in the July issue instead of the usual August issue. Since August 1982, tabulations at the two-digit Standard Industrial Classification (SIC) code level have been available for

1958–81 through the REIS. Estimates for the years 1929–57 have been revised, and tabulations (one-digit SIC code level) for these are also available through the REIS.

Annual state disposable personal income. Annual estimates of total and per capita disposable personal income for states are released as a companion series to the revised annual state estimates of personal income and are published in the August issue of the *Survey*. The state disposable personal income series is consistent with the state personal income series for 1958 and subsequent years.

Annual county personal income. These estimates become available approximately 16 months after the close of the subject year. Revised estimates are available for each year of 1969–80. County estimates for selected principal years (1929, 1940, 1950, 1959, 1962, and 1965–68) have not yet been adjusted to the revised national income series. Summary statistics are published in the April issues of the *Survey*. Tabulations for the most recent six years (personal income by major source and earnings by one-digit SIC) are available each July in a nine-volume publication entitled *Local Area Personal Income*. The most recent publication includes the years 1975–80.

Transfer payments. The component estimates of transfer payments by county are unpublished. However, tabulations of transfer payments by type of program are available from the REIS for the years corresponding to the county personal income series.

Farm income and expenditures. These estimates of gross receipts and expenditures, which underlie the net farm income estimates in the state and county personal income series, are unpublished. However, tabulations for the years 1969–80 are available upon request from the REIS.

Average annual employment for states and counties. These unpublished estimates are a companion series to the personal income estimates. They are constructed from similar sources using the same concepts and definitions. Tabulations are available from the REIS for 1967–80.

Much of the data underlying the personal income estimates are obtained directly from federal and state government administrative records, with the condition that the Bureau of Economic Analysis observe the federal and state regulations established to safeguard the privacy of individuals and individual businesses. Therefore, the BEA personal income estimates are subjected to rigorous scrutiny to determine if any data cells might disclose the activities of a single firm or reporting unit. Such cells are suppressed in the final tabulations. Because of the difficulty of adequately protecting against the inadvertent disclosure of confidential information, it is the policy of the BEA to release estimates for two-digit SIC code industries for regions and states only, and for one-digit SIC code industries for counties, standard metropolitan statistical areas (SMSAs), and all other geographic areas aggregated from the county estimates. The discontinuation of the tabulations for BEA economic areas has resulted in fewer data cell suppressions for counties and SMSAs.*

The Bureau of Economic Analysis has a good record of providing services to other BEA units and to the user community through the REIS. With only a small staff assigned to user services, the system has generated and maintained a very large data base (approximately 64 million data items), generated approximately 1,300 pages of published statistics per year, distributed approximately 15,000 pages of standard public-use tables to the 189 members of the BEA User Group each year, and responded to over 1,200 additional data requests per year involving approximately 50,000 pages of computer printout (most of which are completed within 48 hours of receipt of the data request). The charge for these additional requests is currently only $2.00 per table. Under normal operating conditions, any public-use table or group of tables can be produced overnight. In short, the system has managed to keep pace with the rapid expansion in the use of state and county personal income estimates and has met the needs of most of its users at minimal cost.

The system is not without problems, however. The system falls short of the speed, flexibility, and user convenience offered by more up-to-date on-line data base systems. While the Regional Economic Information System has met the needs of most users, some econometricians have had difficulty with the system's tables. This has recently been corrected so that time series files are now available. The system has undergone significant change during this past year so that it now resembles an on-line system. The major public-use data files are stored on-line, and interactive software has been added to provide improved access to these files. Future developments will include the addition of or coordination with software for graphic and statistical analysis.

The regional information program of the BEA provides the most comprehensive time series currently available for multiregional modeling and analysis. The REIS incorporates about 400 source data series comprised of all applicable survey and census statistics and administrative record files such that the resulting measures are comparable over time,

* The BEA economic areas are nodal (functional) economic areas consisting of an SMSA at the center and a hinterland composed of surrounding nonmetropolitan counties based on commuting data from the decennial population censuses. These areas, unlike SMSAs or other functional delineations, cover all of the United States. They have been discontinued this year because the 1980 decennial source data were unavailable; statistical interactions that were formerly significant are less so now, using 1970-based boundaries. Moreover, fiscal stringency prohibited the availability of resources for redefining their boundaries when the source data become available. The BEA economic areas were originally defined for use in the regional projections and impact modeling systems that the BEA had under development. Insofar as they enclosed the commuting fields of workers, the areas appeared to provide an ideal delineation for (1) maximizing statistical interrelations based on source data generated at both places of work and places of residence, and (2) enclosing impact areas where most local services are produced and consumed by persons residing within the areas. (The BEA regional modeling system and its applications in regional policy programs will be discussed in the next section.)

among states and counties, and with measures in the national income and product accounts. This is not to suggest that the REIS represents the single most important regional data base. On the contrary, it accounts for only a small fraction of the data inventory for local economic development planning (Davis and Wolman 1981).

The Census Bureau, which is the leader among federal statistical agencies in the provision of user services, has had a mixed decentralized approach in information dissemination. The demand for specialized services and machine-readable files had increased so much by the early 1970s that the Census Bureau established privately owned summary tape-processing centers to provide these services from 1970 census files. The Census Bureau has since established a National Clearinghouse for Census Data Services. Organizations that provide data services from the Census Bureau files, including many of the tape-processing centers from the 1970s, are registered with the Clearinghouse. In preparation for dissemination of 1980 census products, the Census Bureau has established State Data Centers. The data centers are state agencies that receive census products and support free of charge and in turn agree to disseminate the information within their states. The Census Bureau also provides data services through the Data User Services Division in Washington, DC and through User Service personnel in each of the 12 district offices.

With the 1980 census, the Bureau introduced CENSPAC, a file of 77 reels (6250 bytes per inch) and related analytic software. However, the privately owned summary tape-processing centers that originated with the dissemination of the 1970 census files have not reduced their business. Privately owned information services face a growing market. In the September 1982 issue of *American Demographics*, for example, ten individual private information service organizations advertised their computerized demographic information capabilities. One, DUALabs, advertises that it delivers the same information on the decennial census as the Census Bureau, but on only one-quarter the number of reels and at one-third the price. Indeed, it advertises more efficient (less costly) software services than CENSPAC.

Notwithstanding the availability of services from private groups, the Census Bureau disseminates to these groups and other users a prodigious array of data and services in connection with its decennial population census, as well as with its more frequent household and industrial surveys and censuses. The decennial population census dissemination program will now be briefly discussed and followed by a review of the availability of its data on regional and local industry.

The 1980 census will result in an estimated 1,600 publications, 3,000 reels of public-use computer tapes, 32,000 maps, and other sundry products. Detailed demographic, socioeconomic, and housing data will be provided for a variety of political and statistical areas including the whole of the US, states, cities, counties, towns and other county subdivisions, census tracts, blocks, congressional districts, and neighborhoods.

The 1980 Census Publicity and Outreach Program consists of a variety of activities to achieve the following objectives: (1) to acquaint users with the 1980 census products, related technical support, and the product distribution system; (2) to provide timely information about the availability of new products and how to order them; (3) to provide detailed information to users about the characteristics, limitations, and users of 1980 census products; and (4) to distribute products to users on a timely and convenient basis.

The program is divided into three parts:

Publicity: informing users about the 1980 census, its products, and how and where to obtain the products and related information.
Technical support (user services): training courses, written reference materials, and enquiry services to help users understand and use 1980 census data of interest.
Product distribution: 1980 census products distributed by a variety of organizations, including the Census Bureau, to make data acquisition as convenient as possible and to provide for customized services required by the various user groups.

Local industry data are available from three Census Bureau programs. Economic censuses are taken at five-year intervals and include the following separate censuses: manufacturers, mineral industries, construction industries, transportation, wholesale trade, retail trade, service industries, and governments. The Census of Agriculture has been conducted at years other than for those censuses listed above, but by this year it will be on the same time schedule as the others mentioned above. In addition, the Census Bureau has published *County Business Patterns* annually since 1964. These *Patterns* are sometimes construed as "minicensuses" with annual establishment counts and payroll and employment data, but the payroll and employment data in *Patterns* are not fully comparable with data in the censuses. All the census data mentioned above are released in published reports and on microfiche and computer tape. In addition, the *Annual Survey of Manufacturers* offers information at the state level on manufacturing industries' shipments, purchased intermediate materials, value added, employment, and compensation of employees annually. However, these data are not easily reconciled with similar and related aggregates published by the Bureau of Labor Statistics, the Internal Revenue Service (Treasury Department), the Social Security Administration, and the Bureau of Economic Analysis; nor are any of the latter sources easily reconcilable with one another in all respects. This is, in fact, due to differences among similar aggregates in definition and coverage, as well as to differences in reporting required by each of the agencies, which will be discussed more fully in the final section.

Another approach to data dissemination was taken by the Bureau of Labor Statistics. It has developed LABSTAT, a system providing on-line access to the entire BLS data base, mainly consumer and producer price indexes and employment, unemployment, labor force, and productivity data. Output from LABSTAT is available for public use through the National Technical Information Service (NTIS) of the Department of Commerce, although direct user access is still limited to the Department of Labor. The NTIS also disseminates energy-related data from the Department of Energy, communications and broadcasting information, health and health care statistics, birth and death statistics, food and nutrition data, environmental and ecological data, and social welfare information. Most of the data available through the NTIS can be obtained directly from the agencies who collect and prepare the data, frequently in greater detail; the Energy Information Administration is one example (Freedman 1980).

The data files mentioned above are only some of those disseminated by different statistical units in the federal statistical system. There is much more; because of the complexity and decentralism of the US federal statistical system, it would be inappropriate to elaborate further on this subject here (federal policy in improving data dissemination by statistical agencies has been reviewed by Sprehe (1981)).

4. Use of Information Systems

Expansion of the regional program of the Bureau of Economic Analysis was first requested by the Water Resources Council in the early 1960s. At first, the undertaking to produce the Regional Economic Information System and a set of multiregional economic projections was paid for by the Council. Subsequently, funding was by means of a transfer in base from the appropriated budgets of the principal water and related land resource agencies to the BEA, with the additional request that impact models be developed. The remainder of this section will describe the regional economic projections, RIMS II, a simulated regional input–output system, and NRIES, a bottom-up, multiregional econometric model, and their applications with respect to federal programs.

Summary state projections of the Bureau of Economic Analysis were most recently published in the November 1980 issue of the *Survey of Current Business*. Projections providing greater industrial and regional detail were subsequently published in 11 volumes, entitled *1980 OBERS–BEA Regional Projections* (July 1981). The detailed projections are also available on four reels of computer tape ($125 per reel). (The reference to OBERS, which continues to characterize the BEA regional projections in the minds of many users, reflects an acronym based on a former association with a unit of the Department of Agriculture.)

There is considerable interagency cooperation in the projections program. In the 1980 set of projections, published jointly by the Department of Commerce and the Water Resources Council, the Bureau of Economic Analysis cooperated with the Bureau of Labor Statistics, which produced most of the national projections on which the regional allocations were based. Indeed, in the early phases of this program, assumptions used in the projections were reviewed or suggested by the Water Resources Council, the Office of Management and Budget, and other interested agencies; and in all sets of projections, the Census Bureau's national population projections and the national labor force and employment projections of the Bureau of Labor Statistics determined the national control totals for the regional projections.

The regional projections are prepared for the nation, states, BEA economic areas, and SMSAs, and substate portions of the latter two types of area. The aggregates projected for the nation and states are population by five-year age group and by sex, total personal income by major source, and earnings and employment for 57 detailed industrial sectors. Projections are published for the years 1985, 1990, 1995, 2000, 2010, 2020, and 2030. The long-term horizon was determined by the requirements of the Water Resources Council.

Upon creation of the Water Resources Planning Act of 1965, the projections program became an integral part of the comprehensive water resources planning program and the periodic national assessments of water and related land resources. Since the first set of projections, the variety of users has steadily increased to include additional federal agencies, state and local agencies, and diverse private organizations. The projections program relies on the Regional Economic Information System for its development and maintenance of a current regional data base. The availability of a current data base is important for periodic revisions of the projections as well as for revisions during the intervening years. During the period between revisions (approximately five years), a monitoring system is maintained wherein projections are evaluated against actual performance. Deviations of current trends from the projections are associated with incorrect assumptions, comprehensive (benchmark) revisions of the source data, and current events that alter historic trends in the regions. The results of the monitoring efforts are communicated annually to users in the field as requested. More formally, a related article entitled "Tracking the BEA regional projections" is published in the *Survey of Current Business* near the midpoint between the revisions. The last such article was published in April 1976; the next will be published in 1983. The projections program has the capacity for rapid and flexible retrieval of data for use in special projects and tabulations for other agencies, on a reimbursable basis. Special projections are currently being prepared for counties in southern states for the Tennessee Valley Authority and the US Army Corps of Engineers, and an analytic mapping system is being prepared to meet the specialized needs of the Nuclear Regulatory Commission. In the recent past, an interim set of projections was prepared for the Environmental Protection Agency for its administration of a program distributing $4 billion annually to state and local governments for constructing sewerage and water facilities.

The Regional Input–Output Modeling System (RIMS II) was originally developed in the mid-1970s to estimate input–output-type multipliers for use in estimating the secondary regional impacts of public economic development policies. It is capable of estimating (from secondary source data) multipliers for any region composed of one or more contiguous counties and for any of the 496 industrial sectors in the 1972 BEA national input–output table (Cartwright *et al.* 1981). The modeling system can be used to estimate changes in total regional output, earnings, and employment resulting from changes in regional final demand, and has been widely used throughout the federal government. In 1976, the Water Resources Council funded the publication of industry-specific gross output multipliers for all BEA economic areas. In 1977, the Department of Energy funded the estimation of multipliers for all states, and contributed funds for the development of software for estimating full multiplier matrices. Since 1978, the Nuclear Regulatory Commission has funded RIMS II to develop analytic techniques for estimating the regional economic impacts of siting nuclear reactors, as well as for estimating potential industrial impacts of hypothetical nuclear reactor accidents (Cartwright *et al.* 1982). In this connection, RIMS II also estimated supply-constrained multipliers as well as the more usual, demand-driven multipliers. This contract is also funding the development of prototype regional transactions tables, based on coefficient tables simulated by RIMS II. In 1979, the Department of Housing and Urban Development funded this system to estimate the impacts of construction expenditures on SMSAs and to develop a central-city–suburb version of RIMS II. Since 1979, the Department of Defense has funded this system to develop new methodologies, which include integrating RIMS II with the NRIES model (described below) for use in estimating the impacts of closing military bases on local areas and the regional impacts of major new defense facilities, such as the Trident West Coast submarine base and the full deployment of the MX missile system in Nevada and Utah. RIMS II multipliers are available for public use at a cost of $1,000–$2,000 per county-defined area.

The National–Regional Impact Evaluation System (NRIES) is a multiregion interactive econometric model of the US. It is composed of submodels for each state, interregional linkages among states, and national variables. Within each state submodel, output, employment, and wages (each at a 12-industry level of detail) are estimated, in addition to nonwage income sources, state and local government revenues and expenditures, population by broad age group, investment in structures and equipment, and retail sales. The primary use of the system is to estimate through time the state distribution of impacts resulting from policy alternatives (Ballard *et al.* 1980). It has been reported as "the only US operational model with substantial bottom-up characteristics" (Bolton 1982) and as "exploiting the advantages of the input–output *cum* econometric combination" (Kort and Cartwright 1982). It, too, has had substantial interagency funding for its development and application. In 1978, the Department of Energy funded much of the software development of the system. In 1979, the Department of Housing and Urban Development funded NRIES in combination with RIMS II to prepare industrially and spatially disaggregated impacts of the Local Public Works Programs (implemented by the

Economic Development Administration) for the Denver SMSA. Since 1979, the Department of Labor has funded the program for developing periodic baseline forecasts for states and the nation. In 1980, the Department of Energy provided funds for establishing a preliminary methodology to link national input–output tables to NRIES, and in 1982 the same department financed a study in which regional impacts were estimated with respect to applications of selected solar energy technologies in residential and commercial buildings. This contract gave the Bureau of Economic Analysis the opportunity to incorporate the investment sector in NRIES, as well as to continue developing linkages with RIMS II. NRIES has been considerably improved since its introduction in the late 1970s. As well as the addition of a regional investment sector, the number of national variables in the model was expanded to include a complete federal government revenues and expenditures sector, a monetary sector, and a final demand sector that corresponds more closely to the input–output final demand concept in RIMS II. The latter improvement is expected to aid in the various linkages of NRIES and RIMS II discussed above.

5. Recommendations and Perspectives

Much progress has been made in the United States to produce more and better information and to improve its dissemination. Public agencies have sought, with some success, to serve the growing appetites for information. And where the information services of these agencies have been less than desired, private organizations have often bridged the voids, as was illustrated in this chapter with respect to the dissemination of decennial population census information. Bolton (1982) notes other US multiregional modeling developments, apart from the already operational systems of the BEA. He also points out deficiencies in regional information (his priorities): (1) the absence of gross product by industry and region, (2) the requirement for better data on regional investment and capital stock, and (3) the need for migration data, noting that "even the Continuous Work History Sample has proved to have serious snags."

The Bureau of Economic Analysis is constructing an experimental set of estimates of gross state product by industry. A summary description of these and the estimating procedures and data sources are included in Garnick (1980), along with other proposed state income and product accounts. The state accounts and supplementary tables under consideration would be designed to provide comparable information for all states, consistent with the national accounts and tables, and would include: (1) 51 accounts of state income and product, personal income and outlay, and state and local government revenue and expenditure, and related measures showing the interrelationships among the federal, state, and local governments and the business and personal sectors for each state; (2) interstate trade linkages; (3) state-to-state differences in the costs of consumer purchases of goods and services; and (4) supplementary tables providing details of industrial activity and types of expenditure by government, business, and personal sectors in constant as well as current dollars. The development of a full set of state income and product accounts, if mandated and funded, could repair many, but not all, of the deficiencies in the partial, regional information systems currently operating.

At present, single-regional as well as multiregional models are based on statistical series that are not consistent with each other. Nor are many of the series, themselves, comparable over time or from place to place. Moreover, in most regional modeling efforts one is forced to construct one's own data of the regional income and product account type from existing series. These efforts are not only duplicative, they are often weak and incomparable with each other. Ironically, these efforts are often funded by federal policy agencies at greater cost than would necessarily obtain in a comprehensive undertaking by the BEA, where a learning curve could be introduced that would take into account cost efficiencies and product improvements over time, freeing the many private and university-linked econometric services to supply regional information more effectively and comparably.

Bolton's priority for the development and application of migration statistics in multiregional modeling is also shared by the BEA. Some of the Bureau's work on the uses and limitations and the dissemination of the Continuous Work History Sample (CWHS) has been discussed in BEA (1976).

The annual, longitudinal CWHS data provide profiles of social-security-covered workers by age, sex, race, wage level, industry, and county. These data have formed the basis for a number of interindustry and interregional mobility studies. The Social Security Administration (SSA), which prepares the CWHS data (as well as annual files with the same socioeconomic characteristics for self-employed individuals covered by social security), also maintains a current file of employers. This file includes geographic and industry codes for county-level reporting units; but as the file is now maintained, it does not include current payroll or employment data, and historical files have generally not been retained for more than two or three years after the file in question has been updated with additions of new reporting units and deletions of defunct units. Revision of the reporting unit basis for SSA records to mandatory establishment reports and improved file maintenance procedures, along with availability to the Standard Statistical Establishment List (SSEL) maintained at the Census Bureau, would enhance the longitudinal analytic capabilities of the employer file for tracing changes in location of individual business establishments, complementing the CWHS capacity for tracing the patterns of earnings, industry, and place of employment of individual workers over time. In a new employee–employer CWHS file, with the SSEL, workers could be traced longitudinally as they changed industry and area of work in response to plant openings, closures, expansions, or contractions. While other data files are currently used for plant location, expansion, and contraction analysis, the CWHS is the only large data source that could be used to analyze directly the dynamics of regional employment change and, correspondingly, work force mobility in terms of the demographic characteristics of workers.

Problems of data access apply among federal statistical agencies as well as to users outside the federal statistical system. The Standard Statistical Establishment List is not currently available outside the Census Bureau, even for development of sampling frames. Privacy provisions in the Tax Reform Act of 1976 have been interpreted to apply to the individual records contained in the CWHS, and the BEA and other agencies have been denied access to these files constructed for the years 1976 and beyond. More recent actions on the part of the Social Security Administration and the Internal Revenue Service indicate that the BEA and some other agencies will soon regain access to these files, and the BEA will resume developing analytic tables from them for incorporation in the regional modeling programs and for dissemination to other users within and outside the federal statistical system. Regaining access to these files does not settle the issues, raised above, of establishment reporting or retention of historical files, however. And all these issues go to the heart of the problem of constructing integrated information systems in the fragmented US federal statistical system (Malkiel 1978, Garnick 1980).

As a member of the Council of Economic Advisors, Malkiel served as chairman of the federal interagency committee on economic statistics from 1975 to 1977, and noted four problems confronting the federal economic statistical system: "(1) lack of comparability of data series; (2) fragmentation and poor data quality; (3) nonoptimal funding patterns; and (4) susceptibility of the system to politicization." He also rejected full centralization of the statistical system as impractical, but saw improved coordination of the system as fully practicable (Malkiel 1978, pp. 81–88). Some of the issues in improving the coordination of general-purpose statistics and administrative records are elaborated on in a report to the Federal Committee on Statistical Methodology (Department of Commerce 1980). What has to be done to improve the statistical system is well known. The Federal Statistical System Project of the previous national administration produced a set of options on which there was substantial agreement in the statistical community; this, after a long history of unrealized recommendations from previous commissions. Unfortunately, statistical policy reform is complicated and requires a relatively long time to produce results. The payoff in terms of reducing the paper burden on respondents, lower costs for producing the required statistics, and vastly improved statistics is quite substantial, given the appropriations devoted to statistics. But such appropriations are still quite small in the entire federal budget and the issues are neither glamorous nor immediate. So complete reform is nowhere on the horizon; the statistical community will likely inch forward, effecting smaller improvements at bigger costs than necessary or desirable, so long as unduly restrictive interpretations of privacy and confidentiality provisions of legislation with respect to data bases are made to preserve the monopolized turf of the authorized statistical agencies.

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References

Advisory Commission on Intergovernmental Relations (1981) *Studies in Comparative Federalism: Australia, Canada, the United States and West Germany* (Washington, DC: ACIR), M1 30.

Advisory Commission on Intergovernmental Relations (1982) *Tax Capacity of the 50 States: Methodology and Estimates* (Washington, DC: ACIR), M1 34.

Ashcroft, B. (1980) The evaluation of regional policy in Europe: A survey and critique. *Report*, Centre for the Study of Public Policy, University of Strathclyde, Glasgow.

Ballard, K., R. Gustely, and R. Wendling (1980) National regional impact evaluation system: Structure, performance, and application of a bottom-up interregional econometric model. *Report*, Bureau of Economic Analysis, Department of Commerce, Washington, DC.

Bolton, R. (1982) The development of multiregional economic modeling in North America: Multiregional models in transition for economies in transition. *Multiregional Economic Modeling: Practice and Prospect*, eds. B. Issaev *et al.* (Amsterdam: North-Holland), pp. 157–170.

Bureau of Economic Analysis (1976) *Regional Work Force Characteristics and Migration Data* (Washington, DC: Department of Commerce, Government Printing Office).

Cartwright, J.V., R.M. Beemiller, and R. Gustely (1981) *Regional Input–Output Modeling System: Estimation, Evaluation, and Application of a Disaggregated Regional Impact Model.* (Washington, DC: Bureau of Economic Analysis, Department of Commerce).

Cartwright, J.V., R.M. Beemiller, E.A. Trott, and J.M. Younger (1982) *Estimating the Potential Impacts of a Nuclear Reactor Accident* (Washington, DC: Nuclear Regulatory Commission).

Davis, B., and H. Wolman (1981) *Local Economic Development Data Inventory* (Washington, DC: National League of Cities).

Denison, E. (1979) Explanations of declining productivity growth. *Survey of Current Business*, Part II.

Freedman, S.R. (1980) Organization, integration and access of metadata in the energy information administration. Unpublished, Energy Information Administration, Department of Energy, Washington, DC.

Garnick, D.H. (1980) The regional statistics system. *Modeling the Multiregional Economic System*, eds. F.G. Adams and N. Glickman (Lexington, MA: Lexington Books).

Garnick, D.H., and H. Friedenberg (1982) Accounting for regional differences in per capita personal income growth, 1929–1979. *Survey of Current Business*, September.

Kort, J.R., and J.V. Cartwright (1982) Modeling the multiregional economy: Integrating econometric and input–output models. *The Review of Regional Studies*.

Malkiel, B. (1978) Problems with the federal economic statistical system and some alternatives for improvement. *The American Statistician*, August.

Muller, T. (1982) Regional impacts. *The Reagan Experiment*, eds. J. Palmer and I. Sawhill (Washington, DC: Urban Institute Press).

OECD (1980) *Regional Policies in the United States* (Paris: OECD).

Schwartz, G., and P. Choate (1980) *Being Number One: Rebuilding the US Economy* (Lexington, MA: Lexington Books).

Sprehe, J.T. (1981) A federal policy for improving data access and user services. *Statistical Reporter*, March.

Bibliography

Bureau of Economic Analysis (1981) *1980 OBERS–BEA Regional Projections: Earnings, Population, Employment, Total Personal Income* 11 vols. (Washington, DC: Department of Commerce, Government Printing Office).

Bureau of Economic Analysis (1982) *Local Area Personal Income 1975–1980*, 9 vols. (Washington, DC: Department of Commerce, Government Printing Office).

Cartwright, J.V. (1980) The intrametropolitan distribution of program impacts: A multiplier analysis. *Selected Papers* from 1980 Annual Meeting of the Council of University Institutes for Urban Affairs, Georgia State University, Atlanta, GA.

Cartwright, J.V., and R.M. Beemiller (1980) *The Regional Economic Impact of Military Base Spending* (Washington, DC: Office of Economic Adjustment, Department of Defense).

Department of Commerce (1980) Report on statistical uses of administrative records. *Statistical Policy Working Paper* 6, Government Printing Office, Washington, DC.

Kort, J.R. (1982) An overview of regional modeling methodology and data requirements. *Paper* presented at Conference of the Association for University Business and Economic Research, Knoxville, TN.

Kort, J.R., and M. Beemiller (1982) Estimating the regional economic impacts of solar energy developments with linked input–output and econometric models. Unpublished, Department of Commerce, Washington, DC.

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CHAPTER 22

Information Systems for Integrated Regional Planning and Policy Making in the Netherlands

Jan van Est, Jan Scheurwater, and **Henk Voogd**

1. Regional Planning and Policy Making

The Netherlands has a relatively strong planning tradition, for at least two reasons. Firstly, because of the "struggle against the sea," there has been a need to maintain the water system and to ensure lasting protection of the reclaimed land. If the Netherlands were to lose protection of its dunes and dykes, half of the country – the most densely populated parts – would be flooded. Secondly, the country has a high population density. The average density is well over 400 people per square kilometer, rising to 1000 in the western part of the country. This West Holland conurbation is called the Randstad or "Rim City," and contains more than one-third of the total population. For a good understanding of these figures a comparison of some population statistics between the Netherlands and the United States is made in Table 1.

Obviously then, plans for the spatial and physical environment must be drawn up and implemented with great care. At the moment Dutch planning is in a transition stage from a "blueprint" to a "process" type of planning, somewhere between direction and guidance. It implies that attention is not so much focused any more on the various plans, but on the related policies, their dynamics, and consequences. Therefore, physical planning is not a policy sector in isolation, but is directed to a specific (i.e. spatial) aspect of many sector policies, which together make up a governmental task. It follows that physical planning legislation is directed to ensure coordination both vertically, between the different levels of administration, and horizontally, within each level of administration.

The governmental organization of planning (Brussaard 1979) is mainly based on three levels of administration: the state, provinces, and 800

Table 1 Areal and demographic statistics, 1970 (sources: US Bureau of the Census 1976, Netherlands Central Bureau of Statistics 1977, van Est 1978).

	Area (1000 km^2)	Population (10^6)	Population density (per km^2)
Netherlands	33.0	13.5	400
Randstad	5.5	5.3	974
Urban areas	1.7	4.2	2,500
United States	1,390.0	203.2	22.5
Standard Metropolitan Statistical Areas	155.3	139.4	141
Urban areas	13.3	110.4	1,315

municipalities. At each level, various kinds of plans are made, both integrated physical and spatial plans and more specific, sectoral plans. Although there are hierarchical relationships between the levels, each one is entrusted to develop its own policy, but within the limitations set by the policies at higher levels. The various departments at each level develop their own sectoral plans for housing, transportation, economics, energy, etc. These plans have to be integrated into the physical planning. The coordination finds its formal basis in the Physical Planning Act, which entered into force in 1965. The law emphasizes policy making by municipalities and provinces. Although the law makes no provisions for national plans, three official government reports have been issued since 1960 and a fourth report is in preparation. The *First* and *Second Report* were very descriptive and clearly reflected a blueprint approach to planning. The *Third Report* showed the new process-oriented approach and contained the objectives and views of the national physical planning policy (see also Chapter 6 by Hinloopen and Nijkamp).

For the provinces the regional plan is the most important instrument. The Physical Planning Act sets forth an overall plan with a highly programmatic character. The plan describes the most desirable development of a region and forms the basis for approval of the allocation plans of the municipalities, which exercise great powers in land-use planning and control. Their councils have been authorized to accept local allocation plans, which are directed toward and directly binding upon the citizens.

The planning system in the Netherlands is decentralized, so that each level of administration can conduct its own policy as long as it is not in conflict with policy on a higher level. For that reason, plans further down in the hierarchy show a diminishing measure of abstraction. Regional plans have an intermediate position.

It has been mentioned that sectoral policies are embedded in physical planning and that regional planning does not imply a planning system in which provincial authorities solely determine the planning process and subsequent decision making. It is much more a coordinated planning system executed by all three levels of administration (Beelaerts van Blokland

1982). Although the local authorities execute and determine the allocation plans, the national government provides the guidance, so much so that regional planning is a national affair, owing to the importance of economic impacts and the small size of the country. In this respect, regional economic policy is mainly based on directives issued by the Ministry of Economic Affairs. Compared with other countries the Netherlands may be looked upon as one region. In this chapter, however, regional planning refers to planning of areas that are, at most, of the size of a province. The Dutch provinces are shown in Figure 1.

Figure 1 The Dutch provinces: bold lines border clusters of provinces; the borders of individual provinces are shown as finer lines.

Section 2 gives a brief overview of some major instruments of regional planning; some general remarks about information systems and data sources in the Netherlands will be made. In subsequent sections, three different regional planning sectors will be discussed in more detail: physical planning, transport planning, and economic planning.

2. Some Major Instruments of Regional Planning

Regional planning in the Netherlands is mainly determined according to policies and rules formulated by the central government (Voogd 1982). The state policy is formulated in general reports, and is further elaborated in Structural Outline Sketches and Structure Schemes. The *Third Report on Physical Planning* was published in parts:

- The *Orientation Report* (1974) outlined national policy objectives.
- The *Urbanization Report* (1976) concentrated on the problems of urban areas in the western part of the Netherlands.
- The *Report on Rural Areas* (1977) introduced a functional zoning system on which to base regional policies.

Other published reports include major regional policy statements, such as the *Report on Regional Socioeconomic Policy* (1981) to integrate spatial and socioeconomic policies. The reports are published as policy resolutions and, after passing the Second Chamber of the States General, they receive the status of an official governmental decision.

Structure Schemes are drawn up on behalf of the various policy sectors, e.g. housing, transportation, energy, registration, and landscape conservation. They are long-term policy statements for a sector with regard to its physical aspects, i.e. projections, objectives, and maximum needs for spatial sector activities. The time horizon of the schemes is 25–30 years. The policy described in the scheme should be arranged to fit within the development conditions of the Structural Outline Sketches. The sketches, i.e. reports with a number of maps, provide a clear insight into the entire general spatial development of a region for 10–15 years ahead. They also function to coordinate the sectoral policies horizontally.

From a procedural point of view the sketches and schemes are subject to the procedure of Crucial Physical Planning Decisions. This procedure has been introduced to fulfill general requirements with respect to consultation, publicity, and public participation. It is, however, the Cabinet that takes the ultimate decision. A further elaboration of the sketch and scheme policies is made in sectoral medium- and long-term plans at the national level. Examples are the Multi-Year Plan for Passenger Transport and the Multi-Year Plan for Urban Renewal.

Other instruments at the national level are the right of annulment of decisions of lower authorities; directives on the context of a particular plan; supporting land consolidation plans; changes in municipal boundaries; and protecting town schemes and nature areas.

The provinces elaborate further on the national policy plans. The provincial councils are authorized to accept regional plans, which, however, may not contain regulations binding upon either the municipalities or their citizens. From a formal point of view regional plans can deviate from the contents of structural schemes or sketches. At most the schemes and sketches will serve as a framework for the development of regional plans. If the central government wishes, however, it can use instruments, especially financial means, to affect regional plans.

Regional plans can be drawn for different types of regions, such as urban regions, metropolitan regions, and even larger ones. Regional plans have four different functions:

- a spatial development plan for the region;
- a framework by which to judge the municipal allocation plan;
- a set of directives to affect allocation plans;
- a framework for integration of the different, interdependent developments.

From these functions it can be concluded that regional plans provide means to coordinate, both horizontally and vertically, governmental actions for the development of a region. Still, there are some difficulties in achieving a balanced policy. Sector policies are mainly determined at the national level and the central government is not able to participate in regional planning satisfactorily with respect to spatial aspects. Besides, the planning is unbalanced because the economic sector policy is set up and dealt with as a regionally distributed macroeconomic development policy, a top-down approach. This, however, is too narrow a point of view. The economy should be thought of as a contributive, or bottom-up system rather than a distributive system. Therefore, macroeconomic development is more a result of interdependent and functional regional developments. What is needed is better theoretical support of regional planning. In spite of the fact that the operation of regional policy can go wrong, the framework itself, from the point of view of coordination, is promising.

The local governments, i.e. the municipalities, exercise great powers of land-use planning and control. The municipal councils have been authorized to accept:

- structure plans, which describe future developments of the municipal area in a highly programmed way; and
- allocation plans, which dictate land-use regulations.

A structure plan deals with the same issues as the regional plan. It includes further development of guidelines and plans of higher authorities and serves to integrate allocation plans for different parts of the municipal area.

A municipality is not obliged to draw up structure plans, but the provincial authority can force it to do so. If a municipality is developing a structure plan, either compulsorily or voluntarily, then the higher authorities as well as the surrounding municipalities have to be consulted, according to the Physical Planning Act. A municipality is obliged by law to draw up allocation plans for the non-built-up areas, and may do so for built-up areas (e.g. in the case of urban renewal). Such plans not only indicate, but, even more strongly, dictate land use and the use of relevant physical resources. The plan can be made effective by building and construction permits.

3. Information Systems for Regional Planning: General Remarks

"Information system" is a loosely defined concept in this context (van Est 1982). So many people, agencies, and departments are involved that a clear definition of the people and procedures that make up an information system is not possible for the whole planning process.

Gathering and processing data are not ends in themselves. The usefulness of these activities depends on the necessity of the information for the planning process. The crucial element is the availability of relevant data and information. Although information is the driving force behind planning, the lack of relevant data and processing tools still leaves gaps between the required and the available information.

Various statistical offices and agencies gather data and information at different levels of aggregation and in different zoning systems. Without coordination these data cannot be used for multipurpose objectives. Planning and policy making are often hampered to a large degree by a lack of such coordination (see also Chapter 15 by van Est and de Vroege).

Several stages can be distinguished in a planning process. Every stage needs particular information. From this point of view, even the whole planning process could be considered as an information system. On the other hand, the planning stages are often more or less independent of each other and hence each stage could be considered as an information system itself. Which definition is more appropriate depends on the purpose of the analysis. In this context, an information system is defined as an instrument that links the user's requirement for information with the data storage and retrieval system that has been set up for processing data for various applications (Scheurwater and Masser 1981).

The design of an information system for regional planning did not receive much attention until recently. Most attention has been paid to the development of various kinds of statistics. The Central Bureau of Statistics (CBS) in The Hague holds a central position in this respect. This (governmental) agency regularly collects all kinds of numerical data, giving similar coverage to almost all policy sectors.

Most information systems presently concentrate on numerical data. However, at the national and regional levels more and more attention is paid to the development of information systems for qualitative (non-numerical) information. This has been encouraged by the introduction of the concept of "monitoring" in (especially physical) planning a few years ago. It means keeping a constant check on how plans actually function in practice: the process of planning and the application of instrument and organizational structures to realize objectives. The planning strategy depends on the monitoring of the system involved and on the analysis of deviations in order to apply instruments to regulate and guide the development of the processes concerned. Therefore, monitoring requires not only a planning system and instruments, but also a system to provide the necessary information. Automated information systems for monitoring are not yet available in the Netherlands, but for the RUDAP system, which is described in more detail in Section 4. Recent experiences with monitoring activities, however, have taught that much of the available data and information are hardly of relevance for monitoring purposes. Data have to be collected at regular time intervals, using the same concept definitions and the same levels of aggregation. It appears very difficult to meet these requirements. One reason is that the data have to be used to make operational indicators that describe (often fuzzy) political issues and notions. This will be discussed in more detail in the next section.

Nevertheless, apart from the CBS, the various governmental sector departments themselves also collect information. Various provincial authorities have developed their own information systems, although these systems are often very modest. Information systems that produce statistics from individual data can usually be found only at a municipal level. Local statistical bureaus often have data that are address- or semi-address-oriented, like housing files and land ownership files, respectively.

4. Information Systems for Physical Planning

The shift from blueprint or final-state planning to process planning that took place in the early seventies in the Netherlands had a number of consequences for information management. First of all, the demand for information changed. It is no longer sufficient to generate the information required for plan making as such. Information is also required to support the realization of plans and to evaluate the achievement of planning goals. A second change, related to this, is the expansion of research activities that are more related to monitoring aspects and continuous planning activities. Elements connected with policy making are gaining much greater emphasis in information provision; examples are social values and attitudes, their dynamics, and factors that influence these dynamics.

Research, planning, and policy making are not independent of each other but closely related and, therefore, constitute an integral system of activities. This implies that an analysis of the planning process can reveal a significant part of the information requirements.

In order to cope with the changing information needs, a continuous analysis of the reality, the planning process, and shifts in attitudes is necessary. This analysis should provide a framework for the information management system. With such a framework the realization of the information management system can be planned with flexibility, giving priority to the issues that are most urgent. With this aim in mind the National Physical Planning Agency developed in the last decade an "information system for physical planning in the Netherlands" (INSYRON) (van Kampen 1978). The purpose of this information system is to provide planners and decision makers with all the basic information they need for research, planning, and decision making. It is based on a theoretical concept of the spatial system, which includes both purely physical elements and elements related to the physical subsystem, such as demographic and socioeconomic data.

For the development of INSYRON a special Information Department of the National Physical Planning Agency (RPD) has been established. Although primarily oriented toward information management for physical planning at the national level, it has gradually evolved into a focal point for spatially specified information for other planning areas as well, and it has connections with research institutes and also with other government institutes at the national and regional levels.

The Information Department does not collect data, but makes use of data collected by other government agencies for their own purposes. These data are not generally collected with sufficient spatial detail for physical planning purposes. In those cases the Information Department stimulates the data collectors to adapt their data gathering to obtain data of greater general usefulness. Precisely because of the integrating character of physical planning, every attempt is made to harmonize data and to use geocoding methods to make data of various spatial levels compatible with each other.

The general framework of INSYRON allows the independent development of subsystems that can be integrated afterwards. Based on priorities set by the RPD, the following subsystems have been developed.

The *Spatial Relations System* (SRS) was developed to relate data of different spatial levels of detail. It consists of two parts, above and below the municipality level, respectively. The smallest spatial unit in the first system is the municipality. For each type of regionalization the municipalities that are included in each region are available. Administrative regions (e.g. provinces), statistical regions (e.g. COROP regions and economic geographic areas; see Figure 2), planning regions (e.g. housing regions), and research regions are included. This system allows the definition of complex regions based on standard regions and the compilation of numerical data for the complex regions based on data for local authorities and standard regions.

The ***Geographic Base Register*** (GBR) is the sublocal authority part of the Spatial Relations System. The register is established in conjunction

Figure 2 COROP regions (bold lines) and economic–geographic areas (finer lines) (COROP: Commission for Regional Development and Planning).

with the Dutch Postal, Telephone, and Telegraph Administration and the Central Bureau of Statistics. It is a nationwide geocoding system that links together place, street name and house number, municipality, sampling district, postcode, and a coordinate reference. The latter is specified on a grid of 500 m squares. Research is being carried out to investigate the usefulness of the addition of segment-oriented registration to the GBR. The main uses of the Geographic Base Register for the National Physical Planning Agency are:

- localization of address-based data for mapping, using the coordinate references;
- aggregation of address-based data to the required spatial level.

The *RUDAP System* has been developed to process numerical data at the local authority level. It contains approximately 3,000 variables for each local authority per year from 1970 onward. The system was developed to provide time series data for the monitoring and revision of the *Urbanization Report* and the *Report on Rural Areas*. The data files contain variables on population (by age, sex, and marital status), birth, death, migration, commuting, employment, housing stock and construction, land use, agriculture, etc. The RUDAP system is an interactive system that can be used by planners and researchers to produce tables for any desired regions and time periods. Analytic and statistical methods for data analysis are also available.

The *Information Bulletin System* is related to the RUDAP system. It provides information, in regularly published form, on quantitative data but also on the state of affairs with regard to the structure and allocation plans and regional plans.

The *BARS System* is a cartographic system of basic maps of the spatial structure (scale 1:25,000), which contain all existing and planned physical elements of regional importance. It is based mainly on information derived from topographic maps and land-use maps, but information from about one hundred other sources is added. The basic maps are stored in digital form in an automatic cartographic system. With this system maps can be produced that contain an arbitrary selection of elements from the BARS system for a required region.

Future developments are mainly directed toward the support of numerical data by (carto)graphic means, and a further decentralization of information use.

The availability of a coherent set of spatially disaggregated data has not only increased the use of information. It has also improved the consistency of data used by a variety of government agencies. In this way, problems in policy making that arise from differences in basic data can be avoided to a large extent.

Several provinces are presently involved in the development of an information system for monitoring their regional plans. Many provinces aim to report on the progress of the various developments on a regular basis. Usually, a progress report on housing is prepared each year, whereas a general progress report is published every two years.

Recent experiences with these two-year progress reports showed the necessity of an appropriate information system. Several provinces decided to develop such a system, some of them making use of the systems that are developed at the national level. However, because of a lack of political priority for such an investment of manpower and money, other provinces decided to shift their monitoring attention from a two-year report to a four-year evaluation report, thus leaving more time to collect and analyze information in a more traditional way.

One of the provinces that is farthest ahead in devising a specific information system for monitoring is North Brabant. Two types of information are distinguished:

- administrative information, such as quantitative information (statistics, forecasts, etc.) and qualitative information (e.g. letters, notes, and plans); and
- maps, which show information with an important spatial dimension.

One of the most crucial decisions in setting up the information system concerned the selection of the required information, as it is not possible to record all the information involved. To be selective, only the main outlines of physical policy must be part of the system.

A regional plan itself is a matter of policy information. For monitoring, the most important statements are processed, i.e. ninety policy decisions in the regional plan of North Brabant. The policy statements are analyzed to determine how they should be monitored. The following questions are answered:

- What are the best indicators of the statement?
- How can these indicators be made operational?
- Are the data available?
- Are extra data necessary, and in what form are they available?
- What organizational structure is necessary to obtain the necessary information?

The intention of North Brabant is to have the information system in operation in 1983.

5. Information Systems for Transport Planning

The starting point for traffic and transportation planning is the *Third Report on Physical Planning*, which sets the framework for sectoral policy. There exists a close relationship between physical planning and the transportation system. It is, so to speak, a "two-way traffic" relationship (Meyer and Goudappel 1977). Scarcity of space and the increasing mobility of the population and urbanization are causing several bottlenecks, especially congestion problems. The high demand for traffic and transport infrastructure requires a transportation policy to be developed in conjunction with an urbanization policy. The interaction of transportation and physical planning implies that decisions concerning the two subjects should be taken at a high (i.e. national) level of administration.

For this reason, a Traffic and Transportation Steering Committee has been set up. It is responsible for the Project Bureau for Integral Traffic Studies. The members of the Committee and the Project Bureau represent the Ministry of Transport, Waterways, and Public Works, the National Physical Planning Agency, and the Dutch Railways. The main task of the Project Bureau is to take care of studies of the relationship between traffic and transport on the one hand and physical planning on the other. The long-term national traffic and transport policy (25 to 30 years) is laid down in the Structure Scheme for Traffic and Transport, which is submitted by the Ministers of Transport and of Housing and Physical Planning to the Lower House. In their covering letter, the Ministers note that public transport is not intended to be based on economic criteria only. Instead, policies will be directed toward an acceptable division of costs and returns, in which great weight is attached to the social significance of public transport.

In general, the Structure Scheme has the following characteristics:

- integrated formulation of plans and policies;
- alignment of policies at different levels of government;
- space for local policies at the provincial and municipal levels, within a policy frame set by central government.

The main objective of national transportation policy is to meet the potential demand for passenger and goods transport under certain conditions, such as that the desired physical structure is achieved, damage to the natural environment is avoided as far as possible, and traffic safety is promoted. From several alternatives the following national policy has been chosen:

- to restrict the growth of mobility (measured in passenger-kilometers), especially of motor cars in urban areas in rush hours;
- to increase the use of other modes of transport, especially public transport and the bicycle.

The long-term network of main roads, comprising motorways and other important roads, is outlined in the Structure Scheme and is developed in coherence with physical planning. The network scheme has been derived as a result of transportation modeling (trip generation, distribution, modal split, and traffic assignment) under the conditions of a distribution of socioeconomic activities. The scheme will be updated every five years. A separate model has been developed for the transport of goods. This model calculates the share of the total flow of goods that is moved by road transport. For traffic, a classification is made of primary, secondary, tertiary, quaternary, and unplanned roads. The central government takes care of the primary roads; the provincial government is responsible for local (i.e. secondary) roads; and the municipalities are responsible for the other roads within their territories.

Public transportation comprises:

- an intercity network, linking parts of the country and concentrations of housing and employment;
- regional public transport for medium and short distances, normally the bus. However, railways will become more important, since high-volume bus links can be replaced by rail links;
- urban public transport;
- complementary forms of individual public transport.

No separate data files have been set up, so far, for road planning. Normally, spatial data will be supplied by other government agencies, such as the Central Bureau of Statistics and the National Physical Planning Agency. The matching of the data causes many problems and consequently gives rise to high costs and limitations for studying transportation problems. Many data on the road networks and traffic are available, but they are filed in different ways in many places.

The Ministry of Transport has made a data file of roads with travel times, accessibility measures, and spatial allocation data. This information system was set up in 1972 and covers fifty percent of all roads, that is, all the primary, secondary, and tertiary roads. What is missing are mainly data on residential streets. Information on the network of roads is stored by coding links and nodes of roads and public transport connections. Furthermore, there are various data files for road attributes, accidents, intersections, speeds, etc. These files are set up and maintained by the various owners of the roads, each in its own way. Only a limited number of these files have been computerized. The evaluation of transportation plans and studies is largely hampered because data are not available and files cannot be linked with each other for this purpose. The lower levels of administration have their own responsibilities for road planning. They have their own data files, which are not compatible with each other.

Special attention has been devoted to the development of an information system for commuting. Individuals perform a number of activities at different places and at various times. As members of production households, people will go to their jobs situated at particular places. To describe the commuting trips and activities as a transportation system, a number of aspects have to be given attention, including:

- a short- or long-term description;
- a disaggregated or aggregated approach;
- description of modal split and cost functions;
- the number of subsystems and their interrelationships;
- the spatial scale.

With reference to the spatial scale, the Randstad can be considered as a multinuclear urban system. The distances to be crossed and all kinds of activities within this region make up a complex system. The resulting pattern of daily journeys to work will change over time, for various reasons. Some are given here:

- An individual changes jobs. Without moving house, he saves on the expense of moving, but the daily trip to work may increase. If not moving turns out to be worse than moving, the individual can move to a location near his work place.
- Suburbanization is not only based on the trade-off of improved living conditions against extra traveling costs. Very often the greater travel distance implies an increase in job opportunities because many suburbs have a good accessibility to other places.
- Industries and business enterprises and local authorities are willing to offer employment and housing opportunities in "open" areas, which now have a good accessibility.

The first two examples refer to the demand side, while the last example refers to the supply side of the infrastructure relevant to the activities of housing, employment, and commuting. From a planning point of view, analysis of the supply side is important for structuring an area, taking into account the availability and scarcity of space. An analysis of the demand side is important in answering the policy questions about the use made of the available infrastructure.

To develop an information system for daily work trips, both the demand and the supply side have to be described. The Netherlands Economic Institute at Rotterdam has developed such a system in which the supply side is taken exogenously. It describes the daily work trip situation for a particular period and is based on housing, employment, and commuting data. On the one hand the information system focuses on aggregate changes in moving house, employment, and traffic flows, and on the other hand it deals with decision-making processes at the micro level. For the aggregate approach the western part of the Netherlands is divided into a zoning system of labor market areas (each of about 100 km^2) and for the micro approach into postcode areas (of about 8 km^2). The system covers a period of five years.

The data for the aggregate approach are taken from a household survey carried out by the Central Bureau of Statistics. This is the Labor Force Sample Survey (*Arbeidskrachtentelling*, AKT) of approximately 3% of all households in the Netherlands every two years. For the micro approach a special and stratified sample of 4,000 households was drawn from the population of the Randstad in 1980.

The AKT surveys contain data about housing and employment conditions at the survey date and in the year before. Stock and flow variables can now be determined for particular times and the period between. The low density of samples causes inaccurate results for detailed zoning systems. For labor market regions the survey figures are satisfactory. The data are available three years after the survey and are used for monitoring and simulation modeling. To quantify these models, data about the housing stock and changes in stock are needed. These data are taken from the Central Bureau of Statistics.

The information system is computerized, with an emphasis on data storage and data editing. For communication with the system one can apply a special user's language. For policy making the information required is available in reports, in which several alternative projects are presented according to various supply alternatives. It is felt that the most important bottleneck of the system is the long period that is needed by the CBS to produce the basic data.

6. Information Systems for Regional Economic Planning

The principal concern of regional economic planning in the Netherlands has been the stimulation of economic growth in those regions facing high unemployment. In the late sixties and early seventies, it was also directed to slowing undesired growth in the congested areas of the western part of the country.

Macroeconomic developments are considered as a regionally distributed national problem, and regional differences as caused by differences in composition of the economic structure. To reduce regional economic inequities all kinds of infrastructure programs and capital subsidies are used as policy instruments. In the seventies, special Regional Development Companies were founded to stimulate promising developments. Also, government offices were moved from The Hague to the province of Limburg and the Northern Provinces. A detailed survey of the meaning and functions of these companies and offices can be found in Folmer and Oosterhaven (1980). Until now, regional authorities have had little direct influence on regional policies. The provincial policies are mainly based on financial instruments, proposed by the central government. Linked to this, attempts have been made to increase vertical integration in the planning structure. However, these attempts have not been very successful.

The most important instruments for regional economic planning are the investment accounts and investments premium regulations. The latter are intended to stimulate extension of existing enterprises and settlement of new ones. The following premiums are in operation:

- investment premiums for industrial enterprises when they move from the Randstad to economically weaker regions, when they extend their plants if situated in such regions, or when new enterprises are erected in such regions;
- investment premiums for "booster enterprises" in the services sector for those enterprises bound to a specific place and with activities fitting the economic structure;

- premium regulations for Lelystad, a new town in the reclaimed area of Flevoland, where a subsidy is given for every new employee.

The Investment Account Act of 1978 made it possible to obtain subsidies and extra premiums when a new investment meets certain conditions. The act was meant to stimulate business investments to reduce unemployment in particular regions.

Attention is shifting from all kinds of interregional equity issues to simple national economic efficiency. As a consequence, increasing interest is shown in the national economic contribution of all types of regional policy measures. This implies a demand for data that offer the possibility to investigate, both regionally and nationally, impacts of economic measures in various regions of the Netherlands.

The Central Planning Bureau (CPB) is a national agency associated with the Ministry of Economic Affairs and is responsible for the provision of relevant economic information to the central government, with respect to regional economic policies. This information is put into a multiregional framework. For coordination of the economic sector policy, the CPB works closely with other government agencies, such as the National Physical Planning Agency. For national planning and policy-making purposes, the CPB provides the following information on regional developments:

(1) descriptions of actual regional economic developments, especially with respect to the labor market;
(2) medium- and long-term forecasts about labor market developments;
(3) long-term demographic forecasts;
(4) impact analysis of regional policy measures.

To derive this information, statistical data are needed. The Central Bureau of Statistics provides data for four different and consistent regional levels:

- economic–geographic areas;
- COROP regions: 40 statistical approximations of labor market zones (Figure 2);
- provinces: 11 administrative zones (including the polders);
- clusters of provinces (i.e. north, east, west, south) (Figure 1).

The following sets of economic data (among others) are available:

(1) Regional Economic Year figures for 1970, 1971, 1973–77, and 1978 (almost). They contain data on employment (man-years), unemployment labor force, total use, and total value added with its component parts, for 15 to 23 sectors in the 40 COROP regions. The same data are available for 23 sectors for the provinces and for 30 sectors for the clusters of provinces. The

number of sectors depends on disclosure rules. Moreover, separate gross investment data for six types of investment goods and for six types of destination are available for the same years and regions.

(2) Limited-information (LI) input–output tables are available for 1960, 1965, 1970, and 1975. These tables contain domestic (i.e. nonregionalized) purchases in 23 sectors and five output categories for the provinces and for some city regions in the west. The general outline of these tables is described by the Central Bureau of Statistics (1970).

(3) Several full-information (FI) intraregional input–output tables and some FI interregional tables are prepared by the CBS and/or some regional research institutes. Only those regions that exerted pressure on the CBS and spent much time of their own were able to construct such tables.

Several remarks can be made about the data. The Regional Economic Year figures are derived from national accounts. For several service sectors they simply represent the weighted sums of employment division rules applied to subsectoral national totals. For other sectors they are based on genuine subsectoral regional data. For most sectors, however, difficult regionalization decisions have to be made in the case of multiregional companies.

The LI input–output tables contain even more regionalization decisions and are, therefore, less reliable. The FI input–output tables are, in fact, further regionalized LI tables. They are mostly constructed by staff members of regional institutes, who are temporarily posted at the CBS. This cooperation has proved to be successful. The FI tables are the more reliable, the more specific the regional knowledge that is used. A lot of guesswork is involved in all cases, however.

Most troublesome are the assumptions made about regional origins and destinations of flows of goods and services. Data on internal transport are available in the Netherlands. They are useful for transport research but may hardly be used to estimate interregional flows in value terms. The difficulties involve: restrictions to goods, incompleteness, unspecified container transport, the existence of transport chains, specification of prices, and assignment of goods to sectors. Nevertheless, internal transport data may be useful in establishing at least some interregional flows.

In preparing multiregional forecasts, the Central Planning Bureau deals with the labor market, population, and the housing market. Other related aspects, such as environmental issues, are also taken into account.

Although an integrated approach to forecasting the subjects mentioned is strongly advocated, until now use has only been made of separate econometric models, i.e. a model for the labor market, including a population submodel, and another model for population forecasting purposes, including the housing market. The latter was developed in cooperation with the National Physical Planning Agency. These two models will be combined to take into account the interactions of the two subsystems.

For model construction the CPB uses a top-down approach, the national developments being used as conditions for regional development, i.e. national economic development per sector and the total population of the country. The models of the CPB are now using two main policy instruments: investment premiums and regional housing distribution policy variables. The CPB uses the provincial level for a zoning system. Furthermore, a separation into size sectors, including the government, is made, while the population is divided by five-year groups and sex. There is a need to regionalize the model structure, so that better use can be made of functional zoning systems, such as housing markets. Moreover, there is growing attention to other economic factors, including investments and production variables. The availability of such kinds of data is stimulating.

Apart from the CPB models the use of data for regional planning is rather limited. Annual figures are rarely used for policy purposes. There is, however, one exception: the estimation of the effectiveness of Dutch regional industrialization policy and extra employment programs. Furthermore, the Central Planning Bureau has built a multiregional investment allocation model using the Regional Economic Year figures. For policy purposes, however, the CPB almost exclusively relies on its multiregional labor allocation model (van Delft and Suyker 1981). Other applications are mostly confined to academic experiments and research. Limited-information input–output tables are rarely used for the subsequent construction of full-information tables. The few FI tables that are constructed, however, are used very often, especially for the Rijnmond area and the Northern Netherlands.

In summary, there are three main fields of application in the Netherlands (Oosterhaven 1981). Firstly, FI tables and the models built on them are used for descriptive purposes. They deal with multiplier analyses and address questions such as which regions contribute to national welfare and what the government contributes to regional welfare. Secondly, they are used for impact analyses. Several regional policy projects, especially for the relocation of state services, have been tackled by (inter)regional input–output models to estimate their economic impacts. Thirdly, programming models have been built, *inter alia*, to investigate the impacts on regional sector structure of energy and environmental policies.

It is important to note that impact and programming analyses require considerably more information than is contained in the FI tables and that this extra information concerns mainly problem-specific data.

7. Conclusions

The regional planning structure in the Netherlands can be characterized as a system of permanent activities in plan formulation, implementation, and evaluation. Realization of plans depends to a large extent on a joint effort of the various levels of administration, and especially on the collaboration of provinces and municipalities.

Because of the decentralized planning system and the variation in decision structures, the usefulness of integrated information systems is limited. General policy issues are too abstract as a base for an information system. Experiences have taught that ambiguity in interpretation can arise and that it is difficult to define appropriate indicators for policy issues. This is partly the reason for the limited consequences of monitoring analysis.

In general, it may be concluded that many different information systems and sources are available upon which Dutch regional planning is based. Unfortunately, the systems vary tremendously in quality and accessibility. Many data sources appear to be incompatible; for instance, because of a different time scale, different zoning systems, or different definitions. In addition, there is some (unproven) feeling that a lot of data are hardly used in planning practice. Many data-gathering activities seem to be passive exercises in the collection and neat arrangement of numbers, which are vaguely thought to be relevant.

The outline of the present situation of data supply in Sections 4–6 shows that further development of policy-oriented research into regional and national economic impacts of particular planning measures is particularly hampered by the cost and obsolescence of full-information input–output tables. On the other hand, the empirical richness of the figures for Regional Economic Years is not used as well as it could be. These two problems are closely related and should be solved simultaneously. Firstly, it is recommended that publication of the Regional Economic Year figures is made quicker, and that the figures are supplemented with data on regional sectoral foreign imports and exports, at least. This will make the figures more attractive for research other than input–output research; and the figures will serve better for updating existing FI input–output tables. The publication of limited-information tables also needs to be speeded up considerably.

Another important issue is that at present all economic data are gathered according to the Standard Sectoral Classification. At the national level in general and at the regional level in particular, this classification is becoming more and more irrelevant for policy analysis. Apart from the old problem of introducing new sectors, this is mainly due to the presence and functions of multinational and multiregional companies. It is advisable to look separately into matters involving these companies.

Until now, regional information systems have primarily concentrated on the collection of "hard" numerical information. Little attention has been paid to qualitative information, despite some promising new developments in the field of regional monitoring. Evidently, regional planning can never solely be based on statistical data bases: qualitative data are also necessary. The qualitative data needed include both "facts" (e.g. approved policies, commitments made, and events) and "opinions" (e.g. public attitudes toward certain issues, proposals under consideration, and information on emerging policies). This is an interesting new avenue to explore.

Most effort throughout the last decade has been put into data collection and data organization. Except for regional economic planning, hardly any attention has been paid to modeling frameworks that allow an understanding of current relationships and projections of trends. However, there are some signs on the national level of physical planning that some more steps will be taken in this direction, especially with demographic data. It is to be hoped that other sectors of physical planning will follow. A routine assessment of linkages and effects of change upon a system should be a necessary ingredient of any monitoring procedure. Models can be used for this purpose, provided that they are linked with an appropriate and up-to-date information base. However, such a situation is not (yet) customary in Dutch regional planning.

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References

Beelaerts van Blokland, P.A.C. (1982) Political philosophy and planning policies: Dutch experiences on different government levels. *Proceedings* of PTRC Summer Annual Meeting, Warwick.

Brussaard, W. (1979) *The Rules of Physical Planning in the Netherlands* (The Hague: Ministry of Housing and Physical Planning).

Central Bureau of Statistics (1970) Regional accounts of the Netherlands. *Statistical Studies* no. 20 (The Hague: Staatsuitgeverij).

Central Bureau of Statistics (1977) *Pocket Yearbook 1977* (The Hague: Staatsuitgeverij).

van Delft, A., and W.B.C. Suyker (1981) Een nieuw multi-regionaal arbeidsmarktmodel: de REGAM. *Report*, Central Planning Bureau, The Hague.

van Est, J.P. (1978) A spatial allocation model for a mixed economy: A Dutch case study. *Working Paper* 9, Research Center for Physical Planning, TNO, Delft.

van Est, J.P., and F. de Vroege (1982) The data source and information carrier as a base for a spatially oriented information system. *Working Paper* 25, Research Center for Physical Planning, TNO, Delft (also published in *Bremer Beiträge zur Geographie und Raumplanung*).

Folmer, H., and J. Oosterhaven (1980) Measurement of employment effects of Dutch regional socioeconomic policy. *Regional Policy at the Crossroads*, eds. A. Kuklinski and J.B. Lamboory (The Hague: UNRISD, Mouton).

van Kampen, C.A. (1978) Netherlands Physical Planning Information System (INSYRON). *Study Report* 5.5, National Physical Planning Agency, The Hague.

Meyer, P.G., and H.M. Goudappel (1977) Urban transportation policies and objectives. *Publication* 77-4, National Physical Planning Agency, The Hague.

Oosterhaven, J. (1981) *Developments in Interregional Input–Output Analysis and Dutch Regional Policy Problems* (Aldershot: Gower).

Scheurwater, J., and I. Masser (1981) Monitoring spatial planning in the Netherlands: An outline of an information analysis system. *Strategic Planning in a Dynamic Society*, ed. H. Voogd (Delft: Delftsche Uitgeversmaatschappij), pp. 193–204.

US Bureau of the Census (1976) *Statistical Abstracts of the United States*, Washington, DC.

Voogd, H. (1982) Issues and tendencies in Dutch regional planning. *Regional Planning in Europe*, eds. R. Hudson and J. Lewis (London: Pion), pp. 112–126.

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CHAPTER 23

Information Systems for Integrated Regional Planning and Policy Making in Czechoslovakia

Antonin Drozd

1. Regional Planning Characteristics

The rapid development of the national economy in Czechoslovakia is bringing about not only a quantitative but also a qualitative growth in production. To maintain or increase the rate of development, it is necessary to improve management and planning. Regional planning at all stages is an integral part of national economic planning. This creates the conditions that enable regional development to play an active role in the formation of a rational structure for the national economy and to direct effectively the complex socioeconomic development of regions, districts, and agglomerations, as well as functionally demarcated territorial units with specific economic problems.

The improvement of regional planning inevitably involves development of an improved information system, because the growth of planning, in both size and complexity, is leading to a sharp increase in the volume of information being dealt with in the planning process. Thus, the time required for preparing planning and management decisions has been increased, as has the effectiveness of planning and management bodies.

The aims of socioeconomic development in regions have also become more interrelated. The improvement of material conditions and the fulfillment of human needs have become more and more the basis for development of the socialist society, and are bringing about the development of new planning methods that require new kinds of information.

With reference to activities outside the production sector, there is a need for information on social aspects and trends, such as the use of spare time and population mobility, which determine the development of society. The vertical, departmental way of planning does not fulfill thoroughly its function of policy making at all spatial levels, and so horizontal interrelations among societies at the regional level are gaining more significance, since the satisfaction of societal needs is associated with the space in which members of society perform various activities.

2. Tasks of Regional Planning

The rational spatial arrangement of socioeconomic activities is a prerequisite for implementing the basic economic law of socialism. On the one hand it is a factor in national economic efficiency, which contributes to the creation of resources for the all-round development of society, and on the other hand the spatial arrangement influences the standard of living through the social infrastructure.

For these reasons the government of Czechoslovakia, in line with the law on national economic planning, issued regional planning regulation 197 in 1974, and the governments of the Czech and Slovak Socialist Republics introduced further regulations in June 1977. The regulations are based on the principle that regional planning provides for the harmonious development of regions as one of the decisive preconditions for continuous and balanced growth of the national economy.

Regional planning, in line with the governmental regulations, has the following main objectives and tasks:

(a) achieving a rational regional structure within the national economy;
(b) determining and developing the basic functions to be fulfilled by individual regions in connection with the socialist division of labor: these functions arise from the natural and economic conditions of regions and from the approved structures of settlements;
(c) balancing economic and social activities in the regional organization of productive and nonproductive industry and environmental care;
(d) directing development of settlements, especially through allocation of housing construction and public and technical facilities;
(e) allocating branches of industry and activities according to the specific circumstances and resources of individual regions so that, in particular, the conditions for effective territorial specialization, coordination, and management of production may be created;
(f) evaluating the economic and social levels of individual regions and determining targets for their development;
(g) achieving a regional balance of manpower resources and requirements, with respect to qualification, age, and sex, by distributing young people and directing migration.

These tasks are implemented through a system of regional plans, which, as far as their contents and planning period are concerned, link up with the system of national economic plans.

In terms of planning period, three kinds of plan are distinguished:

(a) Long-term perspectives (for 15 years) determine the basic directions of regional development with respect to the mutual links with elements of sectoral development.
(b) Medium-term regional plans (for a period of five years) specify the regional balance of aims and tasks that are specified in the long-term perspectives, and determine the ways of ensuring regional socioeconomic development. At present, the main emphasis of regional planning activity lies in medium-term plans.
(c) Executive plans are used to detail the tasks given by medium-term plans, especially in manpower and investment for construction, including that for housing. Today, however, their function, above all, is to correct medium-term plans on the basis of evaluation of the preceding year. Executive plans cover a period of one year.

In accordance with new measures in the system of planned management in Czechoslovakia, regional planning is gradually shifting to the longer term, i.e. to a period of 10–15 years.

The basic territorial unit in regional planning is an area of a region. For some types or parts of regional plans, a division by districts is used, including traffic channels, or, if need be, by territorial, industrial, or settlement agglomerations.

The basic principle employed when developing regional plans is the agreement of state, regional, and economic plans. This is primarily guaranteed by continuous information exchange and comparison and unification of standpoints of all planning agencies and organizations. Regional plans include tasks, limits, and indicators for the activities of agencies and organizations in the relevant area of a region. Furthermore, they describe economic means of development, differentiated according to the conditions of the branches of industry and the regions. Successful implementation of regional planning requires continuous solution of many methodological and organizational questions, and relies on the information system.

3. Definition of Regional Development Management for the Purpose of Information Provision

Management of regional development is a subsystem of national development management in Czechoslovakia and therefore has the following characteristics. In theory it is relatively autonomous in its aims and functions. It respects the principles of the federal organization of the state. Thus, institutionally, it is organized as two relatively independent systems. Regional development management is applied only indirectly. Management principles are implemented by means of relationships with particular systems or by specifying the required behavior of management objects (e.g. regional economic tools). Its objectives, functions, and behavior are mostly determined through legislation. It creates a firm planning framework, particularly in the institutional sphere.

The latter property has led the Research Institute for Development of Cities and Districts to employ an organizational (institutional) viewpoint by which to define the regional development management system, as shown in Figure 1. However, the system conceived in this way has been unsolvable as a whole, so it has been necessary to demarcate it, as indicated by the broken line in Figure 1. As a basis for this approach, the Institute has taken the main users of the regional development management system to be the Czech and Slovak planning commissions, and to them are linked various institutions.

4. Characteristics of an Information System for Regional Planning

An information system for regional planning should contribute to finding new indicators of regional processes, to the arrangement of these indicators in information files according to the needs of regional development management, and to the provision of stored information of suitable quality in the time required.

An integral part of the information system is its documentation store, whose function is mainly to preserve written and graphic information so as to assist the top management of regional development. The store consists of two basic forms: microfiche, which stores analytic and conceptual articles, as well as results of investigations, etc., and microfilm, which records mostly graphic works and maps regarded as having major importance for regional planning.

In developing an automated information system for regional development management of the national economy, we believe that the system should have the following attributes:

- The information should be in such a form that it can be used for several purposes.
- The overall volume of data stored in the computer systems should be reduced by arranging the data in a hierarchy and aggregating them at higher organizational levels.
- The efficiency of technical means for collecting, transferring, and distributing data should be increased.

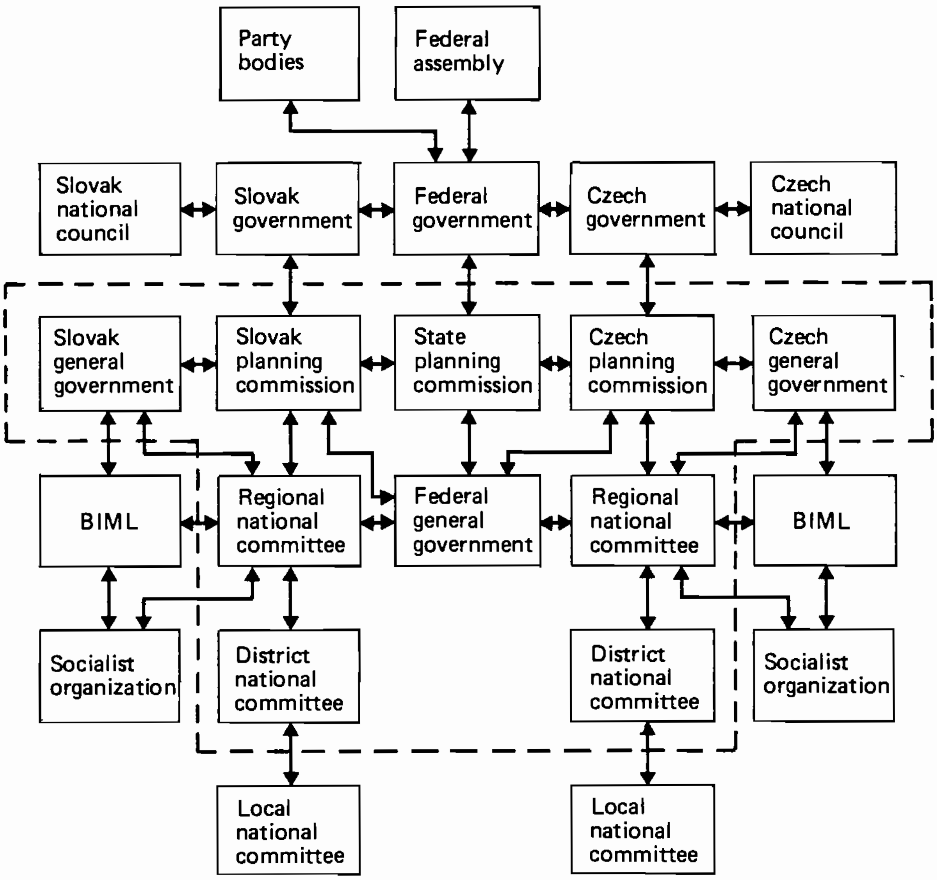

Figure 1 The regional development management system. BIML: bodies of intermediate management links.

- Methods of processing and presentation of information should be rationalized.

We should also take into account some specific considerations:

- The objectives and required behavior of the regional planning system are mostly determined by legislation, and thus a firm framework should be created in the institutional sphere.
- The forms of management are mostly indirect, which implies that individual decision making does not influence directly the elements of regional development.

- The organizational units of the system are not predominantly in a position of direct superiority or subordination.
- Nonquantitative information has to be dealt with.
- The frequency of using and reusing information at high levels of management is lower than at lower levels of management.

5. Organization of the Information System

In order to formulate the basic structure of the information system, the regional development management system is considered as a system with a complicated structure, which can be investigated from various points of view, thus permitting the system to be divided into specific classes of subsystems. We assume that the present top management systems cannot be represented by only one kind of definition of elements and their linkages. In describing the elements and linkages, it is useful to consider the following aspects of management: (1) subject matter, (2) function, (3) organization, (4) information, and (5) technology.

Initially, the most important aspects are the subject matter (problem of indicators) and the functional aspect (involving concrete output information), because the input information will be stored by subject matter and the output information carriers are grouped by function. We maintain that the application of further, more detailed aspects will be useful only at a higher level of differentiation. The relationships between the components of the subject matter and functional aspects of the information system are represented in Figure 2.

The transition of data to information is made in the methodological sphere, where a method or algorithm determines how output information is processed and which data are needed for it. The convention has been applied that data become information only if they communicate something new to the recipient and are supplied to the appropriate place in an appropriate time.

5.1. *Organization According to Subject Matter*

As shown in Figure 2 and Table 1, nine subject matter subsystems (of the first class) have been defined. The input data were filed in nine registers of a data bank. Analysis of the system of regional development management at an overall level has allowed us to resolve these subsystems into individual phenomena, processes, and activities and to determine the kind of output by which every activity is represented. From this more detailed structure we have identified subsystems of the second and third classes, and this has led to definitions of temporally and spatially diversified indicators. The subject matter subsystems of the second class are given in Table 1.

Table 1 Subject matter subsystems of information system.

1.	*Natural conditions*		
1.1.	Geological structure and mineral resources	1.3.	Water
1.2.	Soil	1.4.	Atmosphere, climate
		1.5.	Preserved natural sites
2.	*Population and manpower*		
2.1.	Population: groups of individuals	2.4.	Manpower: needs
2.2.	Population: groups of societies (families, households)	2.5.	Young people: preparation for occupation
2.3.	Manpower: resources		
3.	*Infrastructure*		
3.1.	Transport	3.3.	Communications
3.2.	Power networks	3.4.	Water supply, sewerage
4.	*Settlements and nonproductive sphere*		
4.1.	Housing services	4.6.	Trade, public catering
4.2.	Municipal economy, producer cooperatives	4.7.	Physical training, sport
4.3.	Education	4.8.	Tourist travel, recreation
4.4.	Culture, adult education	4.9.	Banking, administration, other nonproductive activities
4.5.	Health service, social care		
5.	*Productive sphere*		
5.1.	Centrally controlled industry	5.5.	Construction
5.2.	Local industry	5.6.	Industrial supply
5.3.	Agriculture, fishing	5.7.	Science, technical development
5.4.	Forestry		
6.	*Investments and fixed assets*		
6.1.	Investment construction	6.3.	Fixed assets
6.2.	Capacities acquired by investment construction		
7.	*Economic level*		
7.1.	Utilization of natural assets	7.4.	Completion of infrastructure
7.2.	Utilization of economic conditions	7.5.	Investments, quality of fixed assets
7.3.	Development of productive forces	7.6.	Connection with integration
8.	*Standard of living*		
8.1.	Incomes of population	8.5.	Residential milieu
8.2.	Expenditures of population	8.6.	Household conveniences
8.3.	Consumption in kind	8.7.	After-work activities of population
8.4.	Common consumption		
9.	*Environment*		
9.1.	Cleanness of atmosphere	9.4.	Other kinds of environmental depreciation
9.2.	Cleanness of water		
9.3.	Devastation, recultivation of areas		

Table 2 Functional subsystems of information system.

1.	*Methods and management*
1.1.	Creation of legal documents delimiting managerial procedures in regional development, and management of national economy in particular: the role of regional plans; the function of regional plans in the framework of republican plans; development, implementation, and checking of regional plans; relationships between bodies and organizations involved in the development of regional plans
1.2.	Development of methodologies for determining the content, form, and way of submitting draft plans, and for defining the participation and obligations of bodies and organizations in their preparation
2.	*Regional analyses*
2.1.	Analyses of the present and planned rates of utilization of natural and economic resources in individual regions; conditions and limits on their further rational development
2.2.	Regional balances: population and its distribution; manpower resources and their distribution; young people and their distribution; dwelling stock and its development; territorial distribution and utilization of construction capacities in relation to investment construction
2.3.	Analysis of effectiveness of intraregional and interregional relations
2.4.	Analysis of economic development in individual regions
2.5.	Analyses of state and development of productive and nonproductive branches
2.6.	Analyses of state and development of economic and social levels in regions
2.7.	Analyses of development of settlement structure
3.	*Regional planning, prognoses, and concepts*
3.1.	Forecasting
3.2.	Development of concepts (state and development of branches of industry in individual regions)
3.3.	Development of long-term perspectives of regional development
3.4.	Development of medium-term regional plans
3.5.	Development of executive regional plans
4.	*Application of economic tools in regions*
4.1.	Elaboration of standpoints for the allocation of new productive capacities
4.2.	Elaboration of standpoints for liquidation of inefficient productive capacities
4.3.	Approval of regional balances
4.4.	Insurance of regional proportionality by means of stimulative or damping regional economic tools: regional allocations according to estimated costs; reduced rates of fixed assets for a determined period after the end of an investment project; contribution of an investor to a national committee budget for covering induced supplementary investments; allocations to cover costs involved in construction of infrastructure; allocations to cover interest on investment credits; allocations to cover expenditures associated with shifts in production programs; allocations to cover expenditures of training workers and of constructing facilities for apprentices; investment allocations for projects that contribute to regional development, to increase employment, or to implement territorial plans approved by the government; extraordinary allocations for resolving shortcomings in facilities in the borderland
4.5.	Determination of limits to the bodies of intermediate management links
4.6.	Review of progress of investment projects
5.	*Executive management and checks*
5.1.	Proposing sanctions for inadequate agricultural activities
5.2.	Proposing sanctions for pollution of environment
5.3.	Checking activities of enterprises and organizations in the utilization of regional economy tools
5.4.	Providing reports, etc. on regional development to appropriate bodies

5.2. *Organization According to Function*

The functional aspects of the planning information system include the items in Table 2. These aggregations create a basis for formalizing management processes and routine activities that can be represented by algorithms.

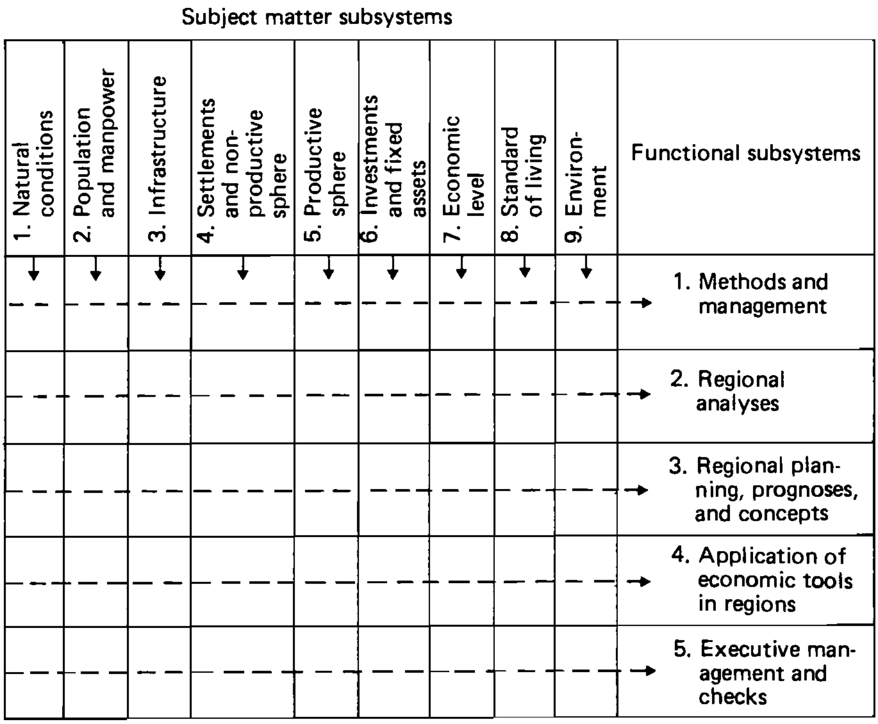

Figure 2 Relationships between subject matter and functional aspects of the information system.

6. Components of the Information System

There are three relatively independent parts in an information system: input data, stored in such a way that they are available for diverse uses; output of information, taking into consideration the appropriate forms of utilization of the data bank; and a set of algorithms and methods to transform the stored data into output information. The diversification of subject matter into subsystems is reflected in the arrangement of the data bank, the data base of which is divided into the corresponding registers. This ensures mutual independence of application programs and data in the data base. The position of the data bank in the information system is illustrated in Figure 3.

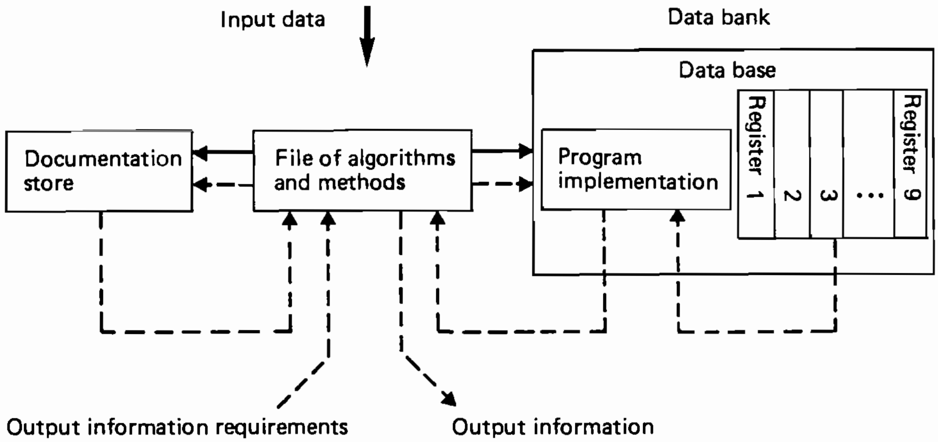

Figure 3 The position of the data bank in the information system. Full arrows: processing of input data; broken arrows: processing of output information.

Three catalogues describing the individual components of the information system have been established: a data catalogue, a catalogue of standard (formalized) output, and a catalogue of algorithms and methods. In addition to the catalogues, a data "passport" card has been designed for communication between persons engaged in solving subject matter problems of regional development management and the designers of the information system. The various components are shown in Figure 4.

The *catalogue of data* provides a survey of which data are or will be stored in the data base, and of their information content. It also serves as a user's manual for specification of data requirements by a question-and-answer technique. The catalogue aids the designers of the information system in making extrapolations from the data bank and its documentation and in making an inventory. It permits connections to be made between individual information systems of the national information bases.

The *catalogue of standard output files* informs the user of the possible standard kinds of output. The contents and form of the output files are decided by the user or are specified on the basis of an analysis of needs for particular decision-making processes. Essentially, the output products depend on the particular problem of regional development.

The *catalogue of algorithms and methods* contains a description of the characteristics of the input and output links with the regional development management system. These links between different types of data flow are shown in Figure 5.

Also, a description of model algorithms is included in the catalogue. The models are only gradually being connected to the integrated information system as they are improved. The biregional decision-making model

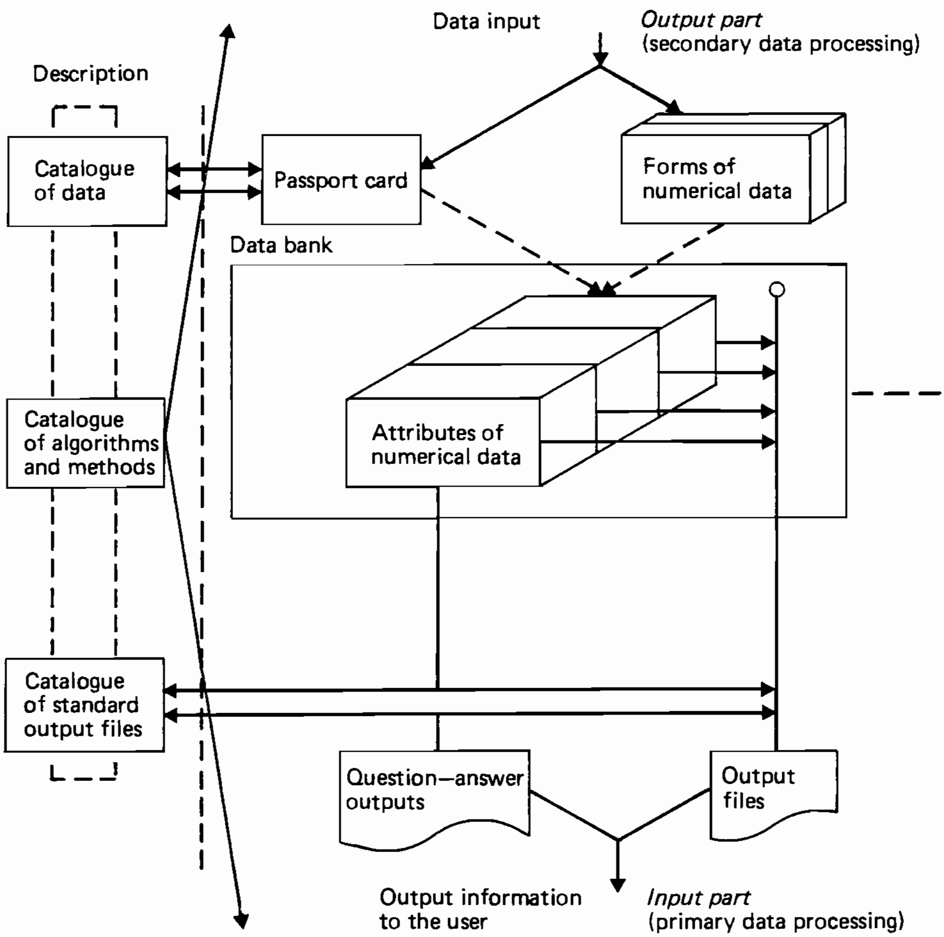

Figure 4 The descriptive parts of the information system in relation to the other components.

of national economic development treats national intentions for economic development as an exogenously given variable, while the regional aspects of this development, i.e. the macroregional division of resources and the qualitative characteristics of their utilization, are determined by solution of the model. It permits not only a top-down procedure (from state to macroregion to region), but a bottom-up procedure too.

The multiregional model of national economic development distinguishes between two groups of regional sectors. In the first group are the branches that create the economic base of a region (industry, agriculture, construction). The second group is composed of the remaining sectors in the productive and nonproductive spheres, and it mainly ensures the needs and services for the regional economy and its population. The output from the model provides a quantitative idea about regional allocation and proportionate internal arrangement of productive forces, and about the overall economic and social development in individual regions.

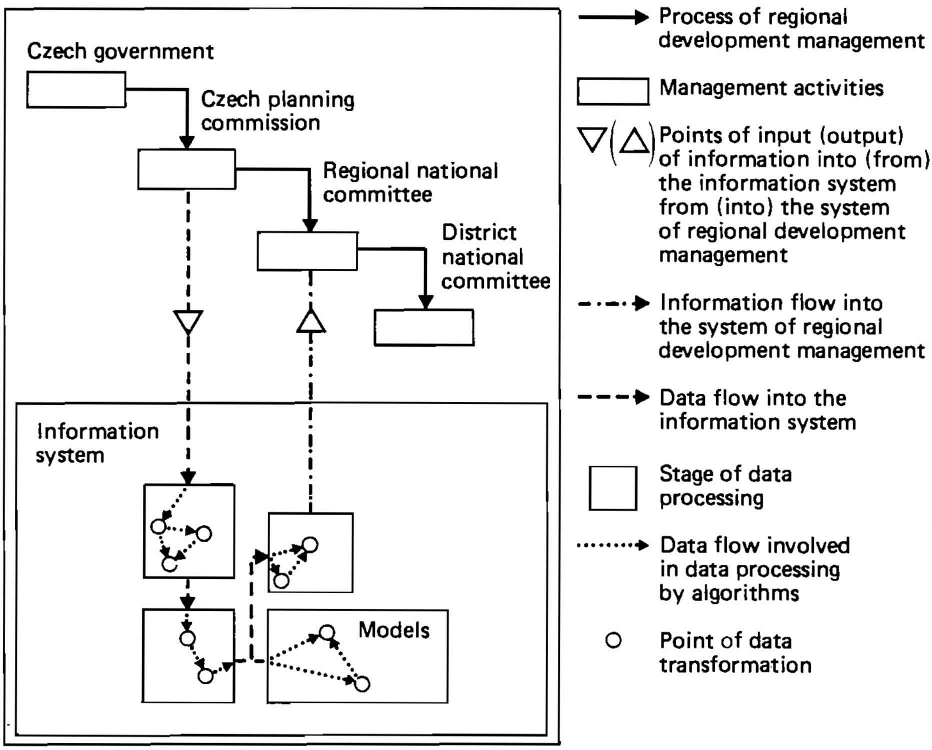

Figure 5 Different kinds of flows of data and information in the system of regional development management.

The information system being developed on the basis of the described methodological approaches is designed to be run on an IBM 370/148 computer system with a central data base.

7. Conclusion

An automated information system has been designed and is being gradually implemented in Czechoslovakia, and some of its subsystems, including population and manpower (316 indicators were utilized and 1,481,580 items of data were stored in this subsystem in 1980) and housing construction planning, have been experimentally verified and are already used in planning practice. Individual subsystems are gradually being completed, with respect to subject matter and functional utilization for the needs of planning bodies.

The development of this information system and the research into regional development management in Czechoslovakia have revealed a range of problems. At the same time, some possible ways of solving them have been found, where positive results have been achieved in the provision of information for regional development.

This chapter could only address some aspects of the information system for socioeconomic regional development planning. The implementation of the information system will require a large amount of research, and the research endeavors of individual countries will have to be coordinated so that progress may be accelerated.

Bibliography (in Czech)

Drozd, A. (1977) Selected problems of an automated management system for the regional development of the national economy. *Paper* presented at International Conference, Varna, Bulgaria.

Drozd, A. (1981) Methodological approaches to the design of an information system for regional development management of the national economy in Czechoslovakia. *Paper* presented at 3rd Seminar of MNIIPU, Warsaw, April.

Drozd, A., J. Kapounova, and S. Koluchova (1977) Information system for regional development of the national economy. *Report* Z234, Research Institute for Development of Cities and Districts, Ostrava, Czechoslovakia.

Drozd, A., *et al.* (1980) Automated management system for regional development of the national economy. *Report* Z264, Research Institute for Development of Cities and Districts, Ostrava, Czechoslovakia.

Klas, A. (1979) Structuring of an information system in conditions of automation. *Informačné Systémy* 4(2).

Kutscherauer, A., L. Jancura, and M. Vavrikova (1977) Normative analysis of the regional development management system of the national economy. *Report* P145, Research Institute for Development of Cities and Districts, Ostrava, Czechoslovakia.

Soltes, D. (1977) Approach to the formalized description of a data component of an information system. *Statistika* No.7

Stojan, F. (1979) Problems of portraying an information system. *Informačné Systémy* 4(2).

Szturz, P., L. Jancura, and P. Tomanek (1980) Extension of the established data base of the information system for regional development management of the national economy. *Report* P204, Research Institute for Development of Cities and Districts, Ostrava, Czechoslovakia.

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CHAPTER 24

Information Systems for Integrated Regional Planning and Policy Making in Finland

Olli Janhunen

1. Introduction

Among European countries Finland is relatively large and very sparsely populated. With over 300,000 square kilometers of land and about 28,000 square kilometers of inland waters, the average population density is 15.7 per square kilometer; in the densest southern province it is 114.5, whereas in Lapland it is only 2.1.

For administrative purposes Finland is divided into 12 provinces (including the autonomous Åland) and 461 municipalities. The municipalities have self-government and have formed 20 associations for the administration of physical planning and several other groups for different activities (e.g. health care). The municipalities raise taxes independently of the state but the state grants subsidies for certain functions to preserve equal services all over the country. The importance of these subsidies has been growing gradually and reduced the actual independence of the municipalities. Excluding the above-mentioned basic divisions, Finland is divided into dozens of other administrative regions under sectoral ministries and other bodies of the central administration. These regions sometimes coincide with the provincial borders, but very often not.

The industrialization of Finland started relatively late and was heavily dependent on forestry until the Second World War. The share of the economically active population in primary industries diminished by only 15% between the turn of the century and 1940. After that the change in the industrial structure accelerated and from 1945 to 1975 the economically active population engaged in primary production fell from 65 to 14%. In the sixties and at the beginning of the seventies the change was one of the quickest in the world. Uneven growth rates in the southern parts of the country compared with other parts contributed to heavy migration flows. These accentuated regional problems and made regional planning and modeling very difficult since the trends created unfounded expectations of continuous growth in the expanding regions and fears of increasing stagnation in the poorer areas.

As well as regional policy making, strategic and operative planning, modeling, and information production are fairly decentralized in Finland. Since the "actors" are many, a high degree of consensus on policy measures, models, and the structure of information systems must be attained before integrated operational systems can be constructed that have the ability to penetrate the whole regional planning and policy-making process.

2. Regional Planning and Policy Making

This section will describe briefly the organizations participating in the regional planning and policy-making process in both the physical and socioeconomic sectors The development of regional policy measures will then be discussed on the basis of a study carried out in the Office of the Prime Minister (PMO).

The actors in the regional planning and decision-making sectors can be classified according to the nature of their functions roughly as follows:

Socioeconomic planning	*Physical planning*
Office of the Prime Minister	Ministry of Domestic Affairs
Functional ministries	Regional planning associations of municipalities
Provincial governments	
Municipalities	Municipalities

Pressure groups
Central organization of cities and towns
Central organization of other municipalities
Central organization of regional planning associations
Commission for the cooperation of the metropolitan area of Helsinki
Voluntary associations of planners, scientists, etc.

Since the municipalities have self-government, binding directives for planning must be based on legislation regulating the self-government. The present legislation presupposes a municipal plan whose structure and contents in the socioeconomic sector are mainly optional, although it must contain some common elements (e.g. a plan for the production of dwellings). This is understandable when the variety of Finnish municipalities is taken into account. The smallest municipality has a population of 133, whereas the population in Helsinki numbers about 480,000. Municipal areas range from 6 to 15,000 square kilometers.

In the field of physical planning the regional planning associations frame general land-use plans of different stages. The ultimate monopoly of physical planning lies with the municipalities, although the plans must be approved by the Ministry of Domestic Affairs. Rejected plans are returned to the municipalities for revision; they cannot be changed in the bodies of central government.

The planning functions of the municipalities are coordinated by their own central organizations. The first recommendations based on the revised legislation for municipalities were made at the turn of the decade. It is to be expected that progress toward coherent municipal plans is slowest in the small municipalities, with simple societal and economic structures, and in the largest cities, where much more refined methods than average are needed to resolve planning problems and to weigh political options in a complex societal environment.

The regional policies of the state are coordinated by the PMO. Tasks include the preparation and implementation of regional legislation, framing of plans according to different time spans, and regional modeling. As well as the PMO, sectoral ministries without a regional organization of their own (e.g. education and social affairs) cooperate with the departments of provincial governments, where much of the operative planning takes place.

The scheme in Figure 1 describes the structure and timing of the present regional policy planning system in Finland. Some critical remarks concerning the integration of the system with other planning systems can be made. According to the scheme the municipalities should utilize the provincial plans in their own planning systems but, at least in the seventies, the linkages between the planning system of the PMO and planning systems of the municipalities have been very weak. During the first planning rounds in the seventies the municipalities and the regional planning associations were inclined to use different growth rates than the PMO in the forecasts of regional development. At the same time attitudes to the centralized guidance of planning were not all favorable in the provinces, which had a disintegrating effect on the whole planning system. Declining growth rates in the national economy have since had the opposite effect and made the achievement of common basic premises easier.

Outside the "bureaucratic" planning and decision-making systems, the scientific sector has been relatively active in the analysis of regional planning problems and in regional modeling. When regional problems gained momentum in the seventies, new universities and high schools with research institutes for predominantly regional scientific interests were erected. Discussions and studies of the alienation of citizens from municipal political decision making led to demand for restructuring the municipal planning and decision-making systems at lower regional levels. The outcome has so far consisted of voluntary committees, which frame alternative physical plans to compete with municipal solutions. Whereas confrontations are usual in the cities, in some small municipalities the committees work hand in hand with the municipal authorities.

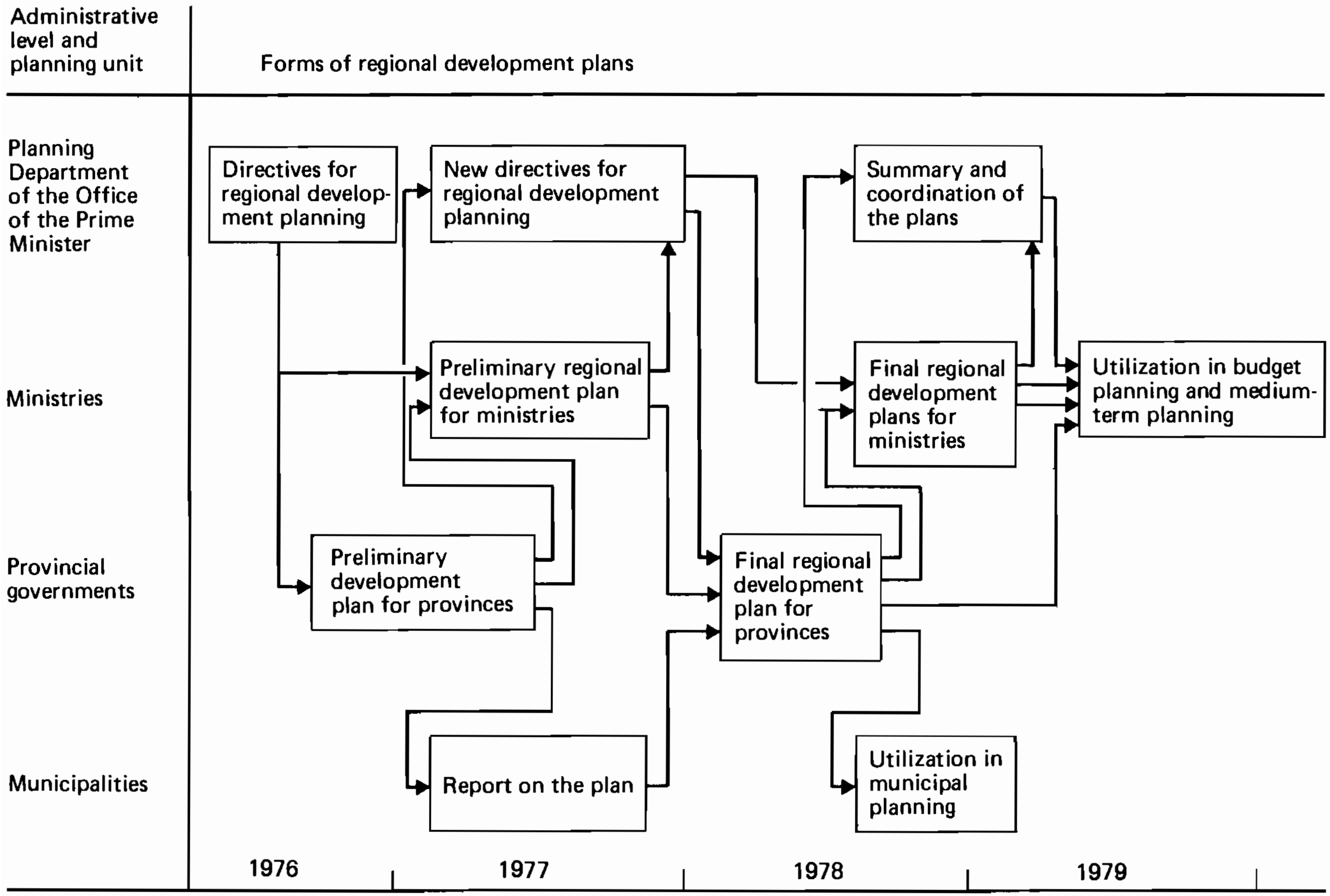

Figure 1 Regional policy planning system in Finland, 1975–81.

2.1. *The Development of Regional Policy Measures*

The following analysis of the development of various policy measures is a quotation from a study of the Office of the Prime Minister (1982), which gives a clear-cut description of Finnish regional policies and their effects.

> Regional differences in the pace of development were taken into account in the allocation of certain appropriations in the state budget as early as the 1920s and 1930s. The earliest specific regional policy measure dates from the 1930s, when regional scaling and zoning for agricultural subsidies were adopted, according to which a relatively larger production subsidy was paid in areas with higher than average agricultural production and transport costs. A similar procedure is still in practice.
>
> In the 1940s and 1950s following World War II, regional considerations were emphasized in the allocation of state employment appropriations for the benefit of unemployment areas in northern, eastern, and central Finland. Investment in regional infrastructure (road networks, power stations, and electricity supply) was also oriented towards these areas to alleviate structural unemployment. The regional employment situation was in some cases also taken into account in plans for siting public enterprises.
>
> The 1958 Act on Tax Reliefs for northern Finland was the first specific regional policy measure aimed at industry. Accordingly, newly established industrial enterprises in the provinces of Lapland and Oulu were exempted from state income and property tax during the period of 1958–1967.
>
> *The first phase of regional policy: Acts on Development Regions for 1966–1969*
>
> The establishment of the Regional Development Committee in 1963 can be regarded as the first phase of systematic regional development policy. The Committee was charged with drawing up a comprehensive economic programme aimed at stimulating industrial and commercial activity in underdeveloped areas, particularly within the manufacturing branch. The first acts on development areas were enacted in 1966 on the basis of bills submitted by the Regional Development Committee. These laws were in force from 1966 to 1969, encompassing, as a general law, the Act on Economic Advancement in Development Areas, and, as statutes, the Act on Tax Reliefs granted to manufacturing industries in development areas as well as the Act on Credits to Development Areas for investment in manufacturing and certain other branches.
>
> The Act on Economic Advancement in Development Areas defined for the first time the so-called first and second major zones for development areas, serving as the basis for regional policy measures in these areas, i.e. tax reliefs and investment credits. In the context of the enactment of these first acts, an Advisory Board for Regional Development was set up as an advisory body to deal with the planning and research for regional development policy.

The second phase of regional policy: Acts on Development Regions for 1970–1975

The second acts for the period of 1970–1975 on development areas were passed in 1969. This legislation includes as a general law the Act on Economic Advancement in Development Areas, and, as statutes, the Act on Credits to Development Areas, the Act on Tax Reliefs granted to stimulate productive activity in developing regions, and the Act on the Improvement of Vocational Training in Development Areas.

The range of measures for regional development was considerably extended during the period the second acts on development areas were in force. The Act on the Regional Development Fund Ltd. entered into force in 1971, as did the Act on Interest Subsidy Credits granted to municipalities located in development areas in order to promote business activity. The Acts on Transport Support for Development Regions and on the Financing of Productive Activities for labour force policy purposes in development areas entered into force in 1973. A decision on building industrial villages in three localities in developing regions was reached the same year.

The third phase of regional policy: Act on Promotion of Regional Development for 1976 to 1981

The second series of acts on development areas was followed in 1975 by a general law applied nationwide on the promotion of regional development, as well as by a statute concerning supports for production activities in development areas. These laws remained in force from 1975–1979 and after minor revisions in 1979 until the end of 1981.

The Act on the Promotion of Regional Development stipulated the operational lines in regional policy for the latter half of the 1970s by seeking to achieve regional policy objectives through government support of production activity and by guiding the choice of location of enterprises and public services. The act additionally obliged ministries and subordinate authorities to focus particular attention on promoting balanced regional development in discharging their functions. Provisions in the act pertained to the support of productive activities in developing regions in the form of investment, start-up, and education and training subsidies granted to enterprises. The majority of the measures initiated by earlier legislation were still in force in the latter half of the 1970s.

Regional policy objectives were of primary importance in the allocation of several other items of central government expenditure as well in the latter half of the 1970s, notably regional support for agriculture, state housing loans, state employment appropriations, and subsidies granted both to local government and the private sector to alleviate unemployment. Regional policy has also played a role in the allocation of credits by the Investment Fund of Finland.

In the past few years, efforts have been made to raise the effectiveness of regional policy through public sector measures by means of specific regional projects intended to improve the prerequisites for growth in some of the least developed parts of the country. Legislative development of public services has also contributed to balancing regional development. The main emphasis in the implementation of several broad educational, social, and health care reforms, particularly those initiated in the early 1970s, was laid at first on development areas.

Municipalities also took an active part in promoting industrial and commercial activities in the latter half of the 1970s. In recent years, construction of industrial estates by municipalities has considerably expanded and a clearly greater number of loans and guarantees have been awarded to enterprises.

The Act on the Promotion of Regional Development also diverged from earlier regional policy general laws in that it prescribed the arrangements of special regional policy planning under the name of the planning system for regional development.

Regional development planning was spread over different administrative levels according to the principle of multilevel planning [Figure 1]. On the intermediate level of administration, regional development plans for provinces were drawn up under the supervision of provincial governments. On the central administration level, the ministry concerned was charged with drafting the regional development plan in the relevant administrative area, taking the provincial plans into account. The Office of the Prime Minister was charged with the responsibility for the control and coordination of regional development planning.

The number of the population and jobs projected for each province also held a leading position in the regional policy planning scheme in the latter half of the 1970s. In this plan, the Council of State ratified the demographic targets set for the provinces, which were to be considered in planning impacting upon regional development.

Summary of the features and impacts of regional policy developments

An overview of regional policy targets going back to the first acts on development areas reveals that a continuously escalating level has been set for regional policy objectives, evident both in the increased number of regional policy subtargets and in the higher goal level for employment and earnings.

The expansion of regional policy and the raised level of objectives have led to a shift from a policy line centred on development areas to a nationwide regional development policy. Legislation on the advancement of regional development introduces as a new goal "the promotion of balanced regional development throughout the country".

As a branch of social policy, regional policy has also altered in character along with the higher level of objectives set for it. Regional policy has grown into a branch regionally sharing and coordinating social policy. Regional policy has thus moved from a sectoral policy built on development measures specifically designed for developing areas towards regional policy impacting upon the other branches of social policy.

A real increase in state expenditure for specific regional policy measures has been the fundamental line pursued. Budgetary appropriations for regional development measures grew swiftly in the 1970s. Regional policy financing in 1980 amounted to approximately two per cent of the final state budget. Subsidies allocated to enterprises in development regions in 1975–1980 totalled 5,200 million marks. Loans and similar subsidies amounted to about 3,100 million marks, a good half of which was credit granted by the Regional Development Fund. The value of assistance and corresponding subsidies was thus a little more than 2,000 million marks.

Regional policy assistance in the form of specific measures has noticeably improved the employment situation in provinces in development areas. According to estimates, regional policy credit and assistance have contributed to creating approximately 40,000 and 41,000 permanent new jobs, respectively. These figures cannot, however, be added together, since loans and assistance have partially been granted for the same projects. The "price of jobs" in regional policy (amount of support per job created) continuously rose during the latter part of the 1970s.

Regionally, specific measures have had a favourable impact on the development areas in zone II in particular [Figure 2], manifest in appreciably expanded industrial investment, production, and new jobs throughout the 1970s. The provinces of Oulu, Vaasa, and Lapland received the majority of regional policy assistance. New jobs created through regional policy support were mainly in the province of Vaasa, while the fewest jobs in proportion to the volume of credits and assistance were recorded for the provinces of Lapland and Pohjois–Karjala located in zone I.

3. Regional Information Systems

This section will concentrate on the register systems, statistical information systems, and data bases, all of which have the characteristics of regularity and constant updating. This consideration excludes many case-study-like information systems that may have had a strong impact on the development of modeling systems.

3.1. *General Features of the Information Systems and Collection of Data*

Finland has a very advanced administrative register system, which is frequently used for statistical and planning purposes. The core of the system is the register of population, the roots of which go back to the sixteenth century. In connection with the 1970 census the coordinates of all buildings were added to the register. The updating was done according to building permits. The coverage was reasonably good, although errors were detected later, especially in areas for which plotting was done from large-scale maps.

In connection with the 1980 census a register of buildings and dwellings was constructed. This corrected the cumulative errors caused by the disuse of buildings. In the building register, information on disuse and change of use will be updated at regular intervals.

During the present decade a register on real estate that integrates legal and planning information will be developed. Steps have also been taken to construct a register on enterprises and establishments with a better total coverage than the present-day registers (limited to the liability to pay turnover taxes).

Various administrative organizations have their own registers, which can be linked together by the identification codes of persons for statistical purposes. For example, the 1980 census linked 14 different registers.

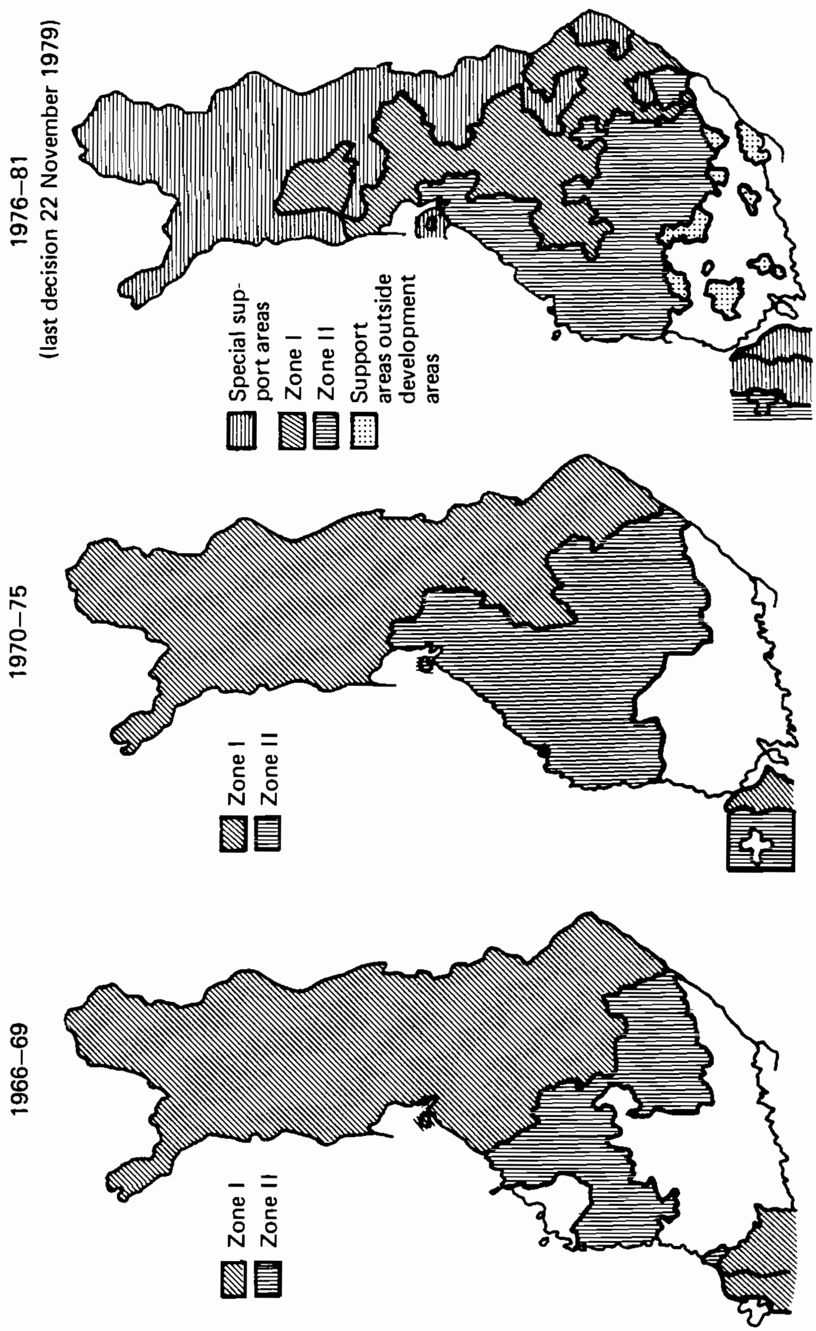

Figure 2 Development areas in Finland during 1966–81.

Only a few questions had to be addressed directly to the respondents.

The maintenance and development of register systems belongs either to the functional organization (e.g. taxation or pensions) or to the administrative branch of domestic affairs. The Central Statistical Office maintains only a few registers.

3.1.1. *Statistical information systems*

The organized production of statistical information is fairly decentralized in Finland. At the national level there are about thirty statistical organizations, although the Central Statistical Office (CSO) bears responsibility for about seventy percent of the total output of statistics. The largest municipalities have statistical systems of their own, based mostly on administrative registers.

The statistical information systems can be divided according to the potential level of regionalization into the following groups:

(1) systems from which statistical information is produced or can be produced on any desired regional level;
(2) systems from which municipal and higher-level statistical information is available;
(3) systems from which only higher-level information is available.

From the register-based statistical systems information on all regional levels is possible. The lowest levels, such as in the population and demographic statistical systems, are grid squares from 0.25 km^2 upward. More than 400 municipalities have defined their own hierarchical small areas. The number of areas is about 15,000, from which some 5,000 are hierarchical levels. The areas are nowadays digitized automatically in the National Board of Survey from the basic maps on which the municipalities have drawn them.

The scientific sector is the principal user of census data on urban agglomerations, which do not necessarily coincide with municipal frontiers. In 1980 the number of urban agglomerations was approximately one thousand.

There are severe problems of confidentiality when new small-area statistical systems are constructed. Although the coordinate system grants possibilities for any desired level of regional accuracy, most types of information are confidential and cannot be delivered if the number of statistical items is not high enough.

Similar problems arise in the second type of statistical information system on the municipal level, when data on entrepreneurial activity are used. Detailed industrial classifications cannot be used even in the large municipalities, and in small ones practically all information on enterprises and establishments is confidential in statistical systems. This situation leads to the establishment of redundant information systems, since some types of information (e.g. number of employees and volume of production) are essential in planning systems and are not considered secret at the level of the enterprise.

In a country like Finland the third type of statistical information systems, that is, systems based on sample surveys or aggregated provincial information, poses a potential threat to the availability of regional information that is detailed enough for planning purposes. Expanding and stagnating areas cannot be isolated inside the provinces or other higher-level regional entities. Sample surveys are mostly used to gather information on economic and welfare aspects of the society.

3.1.2. Municipal information systems

At the beginning of 1981 there were about twenty (now about thirty) so-called register municipalities, which had register-based integrated information systems of their own. For obvious reasons Helsinki has the most complicated and advanced information system, including user-oriented direct access systems for administrative as well as planning purposes.

The revised legislation concerning municipalities placed on them the duty to organize planning. This will enhance the construction of integrated information systems, at least in the cities and towns. It is to be expected that the number of register municipalities will rise rapidly in the near future. Both the municipal central organizations and the central organization of the regional planning associations have working groups or committees for planning strategies and operational solutions for their respective information systems. Some discrepancies have arisen over policies; these will be referred to later in connection with the development of data bases. Schemes of the proposed information systems for the municipal and regional planning sectors are represented in Figures 3 and 4, respectively.

3.2. *Contents and Quality of Information Available*

Generally speaking, regional information in Finland is abundant and accurate enough. But when the situation is scrutinized thoroughly, several problems can be isolated. Some of them were treated superficially in the previous sections (e.g. accuracy of coordinates, lack of detailed regional divisions, and secrecy problems). However, there are more severe problems, the nature of which is inherited from theoretical, conceptual, and technological difficulties. Information production draws its frameworks and concepts from known social theories based on known social phenomena. Although statistical information production in Finland went through a very extensive contextual rejuvenation and expansion process during the first (rich) half of the seventies, the oil crises could not be anticipated and the systems were not flexible enough to produce information on energy stocks and flows fast enough. New information systems had to be constructed with new frameworks and concepts, and this has taken many years. Now, when the spot-market and even OPEC prices are going down, we have a coherent system ready to produce information that was actually needed several years ago. The same phenomenon is seen in the

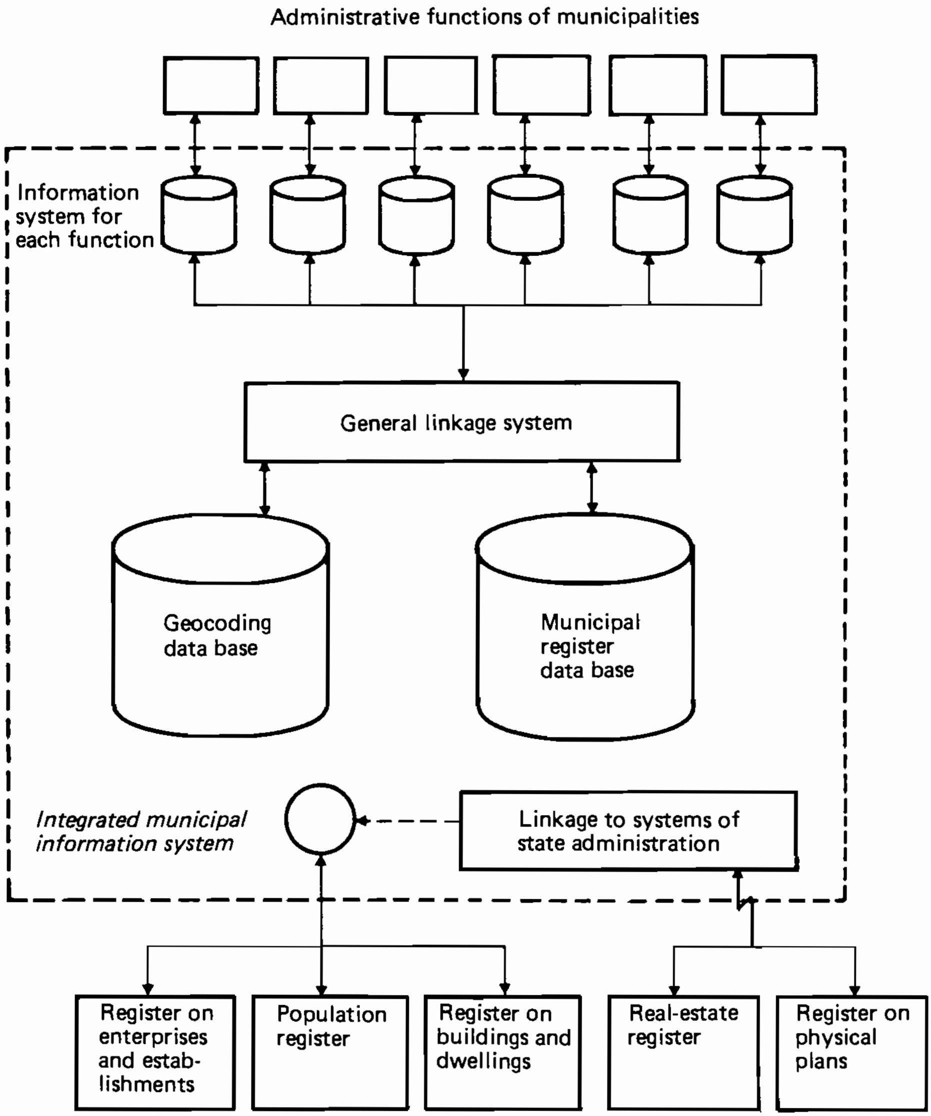

Figure 3 Information system proposed by the municipalities' central organizations (simplified).

environmental sector, although the changes will not be as drastic in the short run as they were during the oil crises.

Another type of conceptual problem characteristic of the Finnish system is that the integration of register systems and statistical information systems is hampered by different concepts and definitions for the same physical or logical phenomena. The register systems use "administrative concepts," whereas the statistical information systems use concepts

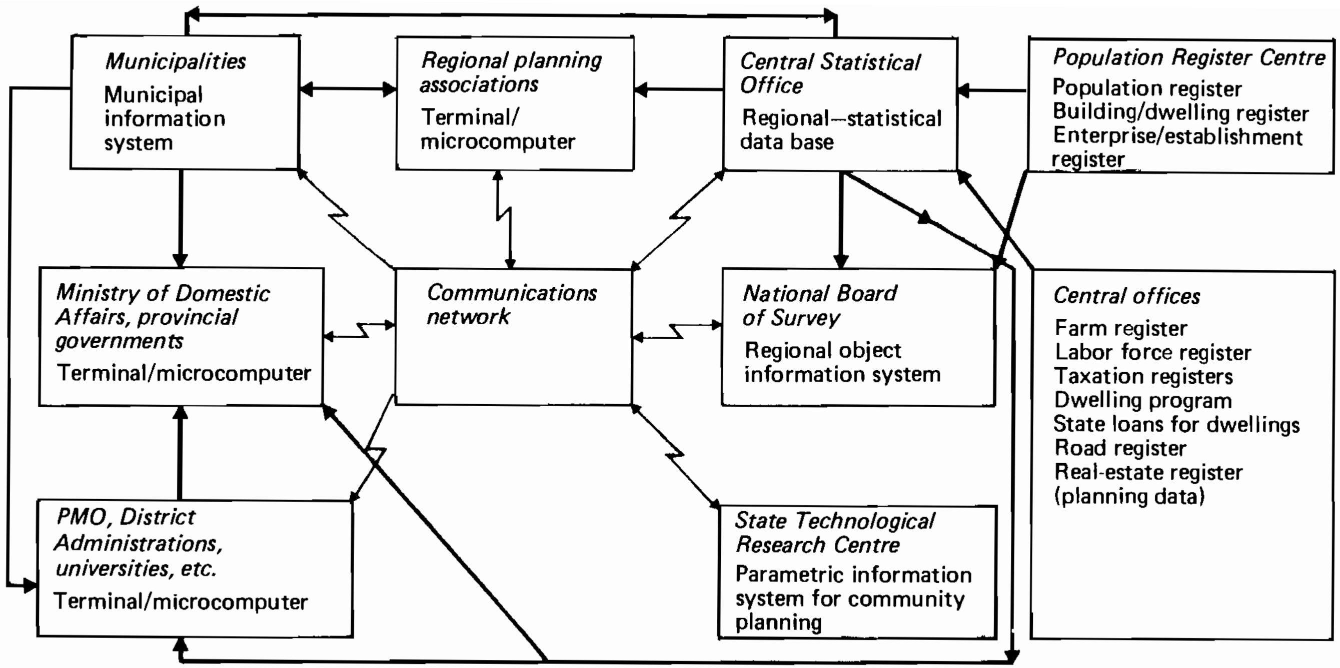

Figure 4 Information system proposed by the regional planning associations.

defined in the social sciences.

There are technological problems in the rigidity of traditional information and retrieval systems. The problem is, however, not purely technological (this will be treated later), but basically contextual. Primary materials of most information systems can be aggregated in millions of different ways, of which a few hundred may be logically and socially relevant but only one is mostly chosen to be published and disseminated. Other aggregations are costly and time-consuming. This may be called the paradox of information production: to produce information means to destroy information. Technological progress may provide tools to avoid this paradox but in the present information systems it still exists.

3.3. *Information Technology*

The register systems and regional statistical information systems use almost exclusively computers, but the system solutions were traditionally one-system solutions with tailor-made programs until the end of the seventies. The adoption of data base systems started at the turn of the decade and the central registers were transferred to mass memories at the beginning of 1983. This section will concentrate on the Regional Data Base, because the updating of basic data for planning and research models is a very labor-intensive operation if it must be done manually from statistical publications and byproducts, even though information is abundantly available. In that sense the Regional Data Base meant a crucial breakthrough in the integration of planning models and statistical information systems of the state and provincial administrations. The information needs for physical planning on the municipal and regional levels focus on grid squares and small areas, for which integrated modeling and direct access data base systems are difficult to construct.

3.3.1. Background and goals of the Regional Data Base

The Regional Data Base (RDB) is an end-user-oriented direct access system for Finnish regional statistical, planning, and forecasting data. It is the second statistical data base of the Central Statistical Office. It was preceded by the Time Series Data Base, which does not contain regional information.

Both data bases have been developed very rapidly using a lightweight systems approach, prototype techniques, and modular solutions that can be changed without changing the basic structure of the system. They are based on aggregate data and cannot be directly linked to the items (i.e. individuals, organizations, etc.) behind the statistics. The smallest possible region in the data base has been the municipality up to now, but in 1983 data on urban agglomerations will be added to the data base. Planning of preliminary tests concerning the direct access system using grid squares, and other small areas goes on in the CSO.

The development of the Finnish regional data base was started in December 1980, after some preliminary research work in the CSO and in some planning organizations and committees. Two of the latter are worth mentioning, because they highlight the Finnish dilemma in the development of statistical data bases for areas smaller than municipalities.

The information system committee of the Finnish association for regional planning proposed the development of a centralized statistical data base referring to municipalities, grid squares, and small areas, the data being collected by the Central Statistical Office from statistical and register systems. The data base would have been part of an integrated information system to be used by regional planning associations. The other integral parts of the system were planned to be a regional system of object information in the National Board of Survey and a parametric information system for regional planning in the State Technological Research Centre (Figure 4).

The electronic data processing committee of the Finnish municipal sector took a different standpoint and proposed municipal information systems based on administrative registers and integrating the production of the municipalities' administrative and planning information. The consequence of this approach in the long run is that much of the statistical material on small areas necessary for planning purposes is produced within municipalities.

These discrepancies are the main reason for the cautious attitude taken toward complicated data base systems in the project that was responsible for the realization and implementation of the regional data base in the Central Statistical Office. Because of scarce resources, statistical data bases provide chargeable services and must regain most of the fixed costs and all variable costs from the users. Investments made for the new methods of disseminating statistics in the CSO must be constantly weighed against the breadth of future use of the systems. On the other hand, the users always face changes in traditional cost structures when they adopt these new systems, which are hard to operate in the short run.

The need for a municipality-level on-line data base system was, nevertheless, unanimously accepted. It was planned and implemented in one year using resources from the Central Statistical Office, the Office of the Prime Minister, and the State Computer Centre. The municipal central organizations and the central organization of the regional planning associations were also tied to the project. The major goals were as follows:

- the widest possible integration with regional planning and research systems;
- flexibility of updating, programming, and analyzing functions;
- a simple user interface.

3.3.2. Design and contents of the Regional Data Base

The widest possible use of the data base requires hardware-independent solutions, which, for the time being, are in absolute terms a practical impossibility. Hardware dependences can, however, be minimized to a considerable degree using optional means of dissemination.

For reasons that will be explained later, the APL programming language was chosen as being optimal for the direct access system of the RDB. Theoretically this decision seemed to be slightly risky because the full exploitation of the capacities of APL requires function keys that are not available on ordinary terminals.

Although the fears proved later to be vastly exaggerated, the system was constructed so that the primary files of the RDB can be copied on tapes, diskettes, etc. for information systems with their own data management products. The direct access system, on the other hand, was constructed so that the RDB can be used without an APL keyboard.

The core of the data base consists of multidimensional matrices that resemble traditional statistical tables. The differences are partly logical and partly due to the longer time span in the RDB compared with yearly statistical publications.

The logical differences originate from the fact that hierarchical classifications are not necessary in a direct access system with built-in classification procedures and computing capacity. The time span is mostly six years, which covers the period between two censuses. It must be admitted that the time dimensions are not long enough for all planning purposes, but the basic material and the available computer capacity did not allow much more. Even now the RDB consists of about 20 million statistical figures, corresponding to about 80 megabytes of direct access memory.

As an example we can take one of the population matrices with three dimensions:

1. Time 1975–80
2. Sex Men/women
3. Age One-year classification

When the final results of the 1980 census of population and housing are implemented in the RDB, the number of matrices will exceed one hundred. The present matrices are listed in Table 1.

Almost all matrices are also available for the basic regional level of the data base, the municipality, as well as for provinces and regional planning areas. Some of the matrices cannot, however, be derived by municipality because they are based on sample surveys or because they are theoretically impossible to be regionalized to this level. The most important of these are the matrices of regional accounts, which are available only by province. Some of the matrices had to be cleared from confidential data since the municipality level with, for example, the standard industrial classification (SIC) produces industrial classes in which there are less than three establishments.

Because many administrative planning organizations use their own regions and because scientific research needs regional divisions that are based on social variables, a file with regional codes and the most important variables, such as area, population, unemployment, and industrial structure, was constructed. With it the user can, for instance, obtain information on municipalities from the third development zone whose income level exceeds the desired level and whose rate of unemployment is lower than a certain percentage. The user can then retrieve information from the matrices of the data base using just those municipalities that met the desired conditions. He can also define regional classifications of his own and proceed as already described.

These features of the system have been widely used in the preparation of regional legislation (PMO) and the planning of new provinces.

3.3.3. The direct access system

The program products of the direct access system were developed by the State Computer Centre. Ready-made products that could have fulfilled the requirements of integrated information retrieval, analysis, and graphics were not available on the open market. The program is an APL-based statistical matrix program with linkages to various standard programs in the APL environment.

APL was chosen because of its excellent matrix-handling capacities, after the rejection of a data base system using primary data. With these solutions the costs to the customer could be reduced considerably. Another reason for the choice was that the language is widely used in planning systems of the state administration, and the integration of planning models and statistical information is easy to achieve. The third reason was the general logic of the language, which is easy to comprehend without formal training.

The program package of the Regional Data Base consists of three parts: matrix retrieval, regional coding, and editing and standard program linkages. The matrix retrieval program allows the user to splice and classify the basic matrix according to information needs. The result is a numerical matrix with no written information or identification codes. The physical position of the data in the matrix of the user defines the dimension (variable) and its classes for every dimension. Texts and codes are brought in later.

The syntax of the matrix retrieval program is a stepwise menu syntax in Finnish, where the user defines: the type of region (municipal/higher levels), the region(s), dimensions (variables), classes for each dimension, and processing alternatives. An experienced user can neglect the menu syntax and define all commands in one sentence, which can also be stored for repetitive use.

Regional coding is done with the help of a slightly revised APL Data Interface (ADI) program, using English query language in the standard parts and Finnish in the revised parts of the program. The classifications of the users are stored in the active work spaces until the user decides to go to the matrix retrieval program with all necessary classifications.

The third part is a mixture of standard programs and programs created for the RDB. The functions produce text for the numerical matrices, count indices and percentages, draw graphs, etc.

Table 1 Contents of the Regional Data Base. For each matrix, the name of the observational variable, the classification variables, and the years are listed.

1.	Population/sex/age/1975–81
2.	Population/sex/age/marital status/75–81
3.	Families/type/sex/parent's age/number of children/77–78, 80
4.	Economically active population/sex/age/industry/80 (preliminary)
5.	Deaths/sex/age/75–81
6.	Migrants/sex/age/75–81
7.	Marriages/sex/age/75–81
8.	Divorces/sex/age/76–81
9.	Births/sex/age of mother/76–81
10.	Population projection with migration/sex/age/81–90, 95, 2000
11.	Population projection without migration/sex/age/81–90, 95, 2000
12.	Population plan/sex/age/80–85, 90
13.	Swedish-speaking population/sex/age/marital status/75–81
14.	Students in comprehensive school and senior secondary level/sex/class/78–80
15.	Examinations/sex/age/level of education/75–81
16.	Offences/type/80–81
17.	Municipal elections/results/76, 80
18.	Production of dwellings/data on completed dwellings/75–81
19.	Stock of dwellings/floor space/80 (preliminary)
20.	Incomes/income bracket/data/77–80
21.	Incomes in farm economy/data/79–80
22.	Manufacturing industries/group of industry/data/75–81
23.	Buildings completed/use of building/data/75–81
24.	Building permits granted/use of building/data/75–81
25.	Stock of buildings/material/use/80
26.	Vehicles/type/75–81
27.	Economy of communes/revenue and expenditure/main budget groups/75–81
28.	Expenditure of communes/detailed headings/75–81
29.	Revenue of communes/detailed headings/75–81
30.	Establishments/group of industry/data/74, 76, 78, 80
31–35.	Various data of labor force, by province and regional planning area
36.	National accounts, by province
37.	Formation of fixed capital, by province
38.	Buildings/use/heating system/fuel/material/80
39.	Buildings/type/material/fuel/heating system/80
40.	Buildings/year of completion/material/80
41.	Buildings/use/year of completion
42.	Buildings/use/number of flats/80
43.	Buildings/owner/use/80
44.	Housing/dwellings/year of completion/80
45.	Business premises/use/use of buildings/80
46.	Floor space of business premises/use/use of buildings/80
47.	Business premises/use/year of completion/80
48.	Business premises/use of building/year of completion/80
49.	Business premises/use/tenure status/80
50.	Floor space of business premises/use of premises/tenure status/80
51.	Rents of business premises/use/rents, expenditure of heating/80
52.	Floor space of rented premises/use/rents, expenditure of heating/80
53.	Rented business premises/use/landlord/80
54.	Business premises/use of premises/landlord/80
55.	Population/age/sex/family status/80
56.	Household dwelling units/type/size/80
57.	Household dwelling units/industry/occupational status/sex/age/size/80
58.	Families/type of family/size/80
59-61.	Families/type of family/economic activity/certain age groups/80
62.	Economically active population/industry/sex/age/80

The on-line environment gives every user up to 350 kbytes of active work space and numerous standard programs for mathematical and statistical calculations, time series analyses, and reporting.

Our experiences show that the matrix solution reduced the costs of reports, analyses, etc. to one-tenth of the costs connected with the more traditional methods of producing the same output from magnetic tapes.

3.4. *The Integration of Information Sources and Systems*

The main goal during the development and design of the Regional Data Base was to secure the widest possible integration of different information systems and sources. For that purpose the Office of the Prime Minister and the Central Statistical Office started a round of negotiations in the state administration, during which the possibilities of adopting the same operational solutions in the sectoral planning systems were studied, and it was agreed which planning information would be linked to the RDB from the statistical systems of other organizations. Up to now the results have been very promising. The planning models of the PMO and most sectors of the Ministry of Domestic Affairs are fully integrated with the RDB. Some sectors of health care and social affairs use the same software, and various other information systems in the APL environment can easily be integrated with the system if information from them is needed in the planning models.

As was stated earlier, the choice of APL seemed at first to thwart the aspirations of integration. Special concern was caused by the decision of the regional planning associations to choose microcomputers without APL keyboards for their administrative and planning activities. However, the problem was solved easily when the enterprise representing the computer produced a diskette simulating the APL code. This permitted the full use of the system's processing abilities. The costs connected with the system and with teletype connections have unfortunately reduced the possibilities of the regional planning associations to use the system. For the municipalities the Central Statistical Office prepares every year a standard report and special reports when they are needed. The universities are mainly interested in tapes from the CSO. Some high schools and regional research institutes are direct access users, however.

Important integration is also happening on the level of equipment and telecommunications. Contemporary text-processing equipment can already function as data base terminals. The first tests have been made in Finland for the construction of gateways between Videotex systems and data bases. The planner would then no longer be tied to a traditional terminal environment. The impact of this development is visualized in Figure 5.

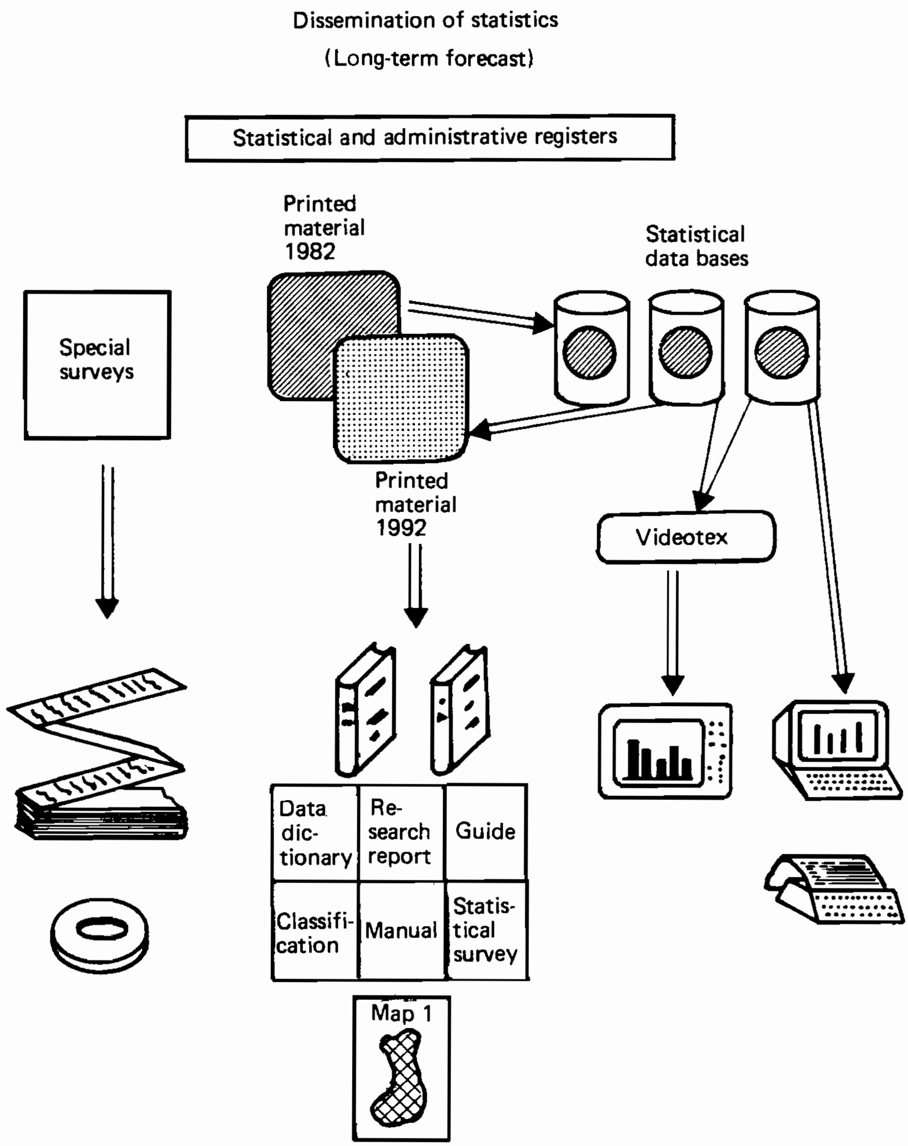

Figure 5 Future prospects for integration of information sources and systems.

4. Use of Regional Information Systems

The output of regional information systems consisted up to the mid-1970s almost solely of publications and printed material. For every model and planning system the basic information had to be collected from separate sources, reprocessed, punched, and run into the files of a model of a planning system. This expensive and time-consuming process severely limited the use of information in the formulation of policy alternatives and decision making. Between 1975 and 1980 the use of magnetic tapes increased somewhat, but separate systems were updated on an irregular basis and shortages of software in the planning and modeling sectors hampered the effective use of information from statistical and register systems. On the other hand, the information systems consisted of independent subsystems with their own system solutions and software, which were very hard to integrate when information was needed from many special sectors at the same time.

The approach that was adopted in connection with the Regional Data Base changed the situation considerably. Most bodies of the central government, all provinces, and some regional planning associations use the data base in their planning activities and increase at the same time the integrated pool of information with their own material. At the moment it seems that the development is accelerating, which raises an intriguing question about the role of operational solutions in the motivation of integration. Instead of planning a complex integrated information system, it may be beneficial to construct a simple, open system, inhabit one corner of a dwelling, open a door, and let others rush in.

This description of the situation is, of course, simplified and many problems remain. The linkages between the old statistical systems and data bases are not smooth enough, the linkages between register systems and separate statistical systems are not fully developed, and the possibilities for some users to use their own computers, hardware, and software are limited for various reasons (bureaucracy, costs, lack of standardization of equipment and communication discipline, etc.). For the moment the scientific sector is plagued the most because standard statistical and econometric programs used in universities and high schools cannot handle the huge amount of data in the data base and have probably, for budgetary reasons, been unable to use the direct access system outside their own data-processing environment. Also, the communication costs of the teletype connections are very high outside the metropolitan area, corresponding to approximately fifty percent of the total user costs, which makes separate solutions very attractive.

Reference

Office of the Prime Minister (1982) An introduction to regional development and policy in Finland. *Report*, Planning Department, PMO, Helsinki.

Bibliography

Kunnallishallinnon Atk-neuvottelukunta (1980) Tietojarjestelmien kehittäminen, tavoitteet ja keinot kunnallisen tietohuollon turvaamiseksi, Helsinki.

Seutusuunnittelun Keskusliitto (1980) Seutusuunnittelun tietojärjestelmien kehittäminen, Helsinki.

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Elsevier Science Publishers B.V. (North-Holland)

CHAPTER 25

International Comparison of Regional Planning and Information Systems

Edwin Hinloopen, Peter Nijkamp, and **Piet Rietveld**

1. Introduction

In this chapter a review is given of the reports on regional planning and information systems from the six countries dealt with in the preceding chapters: Sweden, France, the United States, the Netherlands, Czechoslovakia, and Finland. For the review we will make use of the framework developed in Chapter 18.

From the outset, one should not underestimate the difficulties of carrying out such a comparative review. The number of dimensions involved (e.g. the number of items to be compared) is very large, while only six countries are dealt with. Thus, the conclusions to be drawn can only be tentative. Another problem is that the national reports had to be rather concise, given the composition of the book. Consequently, many relevant subjects are dealt with only in an incidental way.

Another problem that has to be recognized is that the comparability of the reports depends to a certain extent on the ability and insight of the authors of the reports. Because of the broad scope of regional information systems, it would be impossible for one person to know exactly what is going on in the whole field in a particular country. Consequently, observed differences between the national reports do not always necessarily reflect real national differences, but may also arise from the different specializations or affiliations of the authors. In addition, differences due to subjective choices should be mentioned.

A final problem is that rapid changes occur in regional information systems. Therefore, it is not always clear from the reports which statements refer to the actual states of the information systems and which to expected or desired states.

In view of these problems, it is clear that the aim of this chapter can only be modest. We will compare the reports in ***qualitative*** terms for some main topics. For this purpose we will use an ordinal scale to rank the countries according to a particular aspect of planning. This scale says nothing about the magnitude of the differences between countries. In some cases, the reports are not sufficiently informative for a complete ranking to be made. In these cases we have had to use shared ranks (or ties). A first draft of these rankings was sent to the authors so that they could comment on the positions indicated for their countries. This was done in order to avoid any subjective biases on the part of the authors of this chapter.

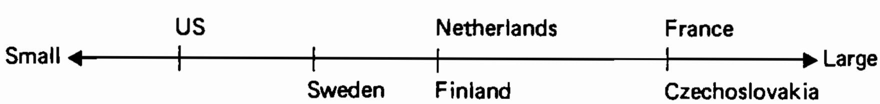
It should be emphasized that the rankings do not necessarily reflect evaluations in terms of better and worse. Their main aim is to give a concise summary of differences between countries with respect to features that are hard to quantify.

In Section 2 the countries will be compared by the structure of their regional planning systems. Attention will be paid, *inter alia*, to the scope and intensity of regional planning as well as to vertical and horizontal coordination in the planning systems. Section 3 will be devoted to a comparison of the regional information systems. Among the subjects dealt with are: integration of information systems, the role of models in information systems, and computerization. In addition, attention will be paid to distinguishing features or weaknesses of particular information systems.

2. Comparison of Regional Planning Systems

2.1. *The Scope of Regional Planning*

As indicated in the general framework for the comparative study (Chapter 18), many potential components of regional planning can be distinguished. The number of components covered is an important indicator of the scope of regional planning in a particular country. The national reports reveal that the majority of the potential planning components are indeed covered in most countries (e.g. transportation, economics, and housing). An exception is the United States, where no overall regional planning system dealing with economics or housing has been developed. The differences between the other five countries are relatively small. The scope of the Czechoslovakian and French planning systems seems to be somewhat broader than that of the remaining three countries. The following ranking of the scope of the regional planning systems is meant to summarize the differences as they appear from the various national reports.



Scope of regional planning.

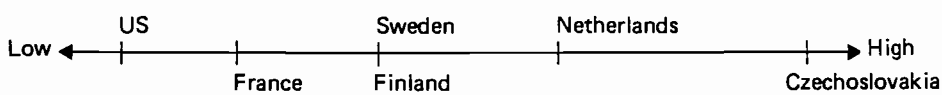
There is one potential planning field that is not mentioned in the national reports, with the exception of Czechoslovakia: migration. Of course, interregional migration is influenced indirectly by, for example, housing policies or regional economic policies, but nowhere has it been indicated as a planning field *per se*. Yet, the subject is important since in the long run interregional migration may substantially modify interregional relationships.

The national reports show clearly that the scope of regional planning is expanding in the course of time. Usually, planning components are added rather than deleted as time passes. Only in rare cases (e.g. the US) do governments decide to follow the path of deregulation so that certain fields are left to the private sector.

The tendency to expand the scope of regional planning can also be observed in a spatial sense. The first phases of regional planning were usually restricted to particular areas, such as depressed regions. In later phases, however, regional planning became nationwide.

2.2. *The Intensity of Planning*

The second feature to be considered is the intensity of planning activities. The intensity reflects not only the number of planning instruments but also their potential impact. A whole range of such instruments can be distinguished. At the one extreme, there are direct measures such as environmental controls or the relocation of employment in the public sector. At the other extreme, one finds very indirect measures such as the formulation of plan figures to be achieved by voluntary cooperation. In between is a group of semidirect measures (especially financial instruments). The differences between the various countries can be represented by the following ranking.



Intensity of regional planning.

This ranking is similar to the ranking obtained for the scope of regional planning. France is the only country that does not fit this pattern: it combines a large scope of planning with a relatively low intensity of planning. This is due to the indicative nature of planning in France; it is based on dialogue and agreement, which implies that it has a relatively low intensity.

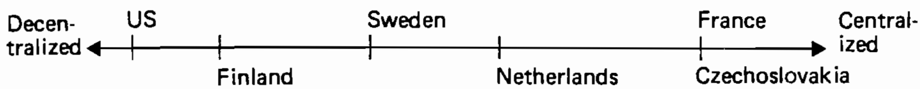
Most reports reveal a tendency toward intensification of planning. The entry of new governments does not remove this tendency, although the United States form a notable exception, as already indicated in Section 2.1.

One may wonder whether this tendency will continue. Clearly, the growing complexity of regional systems requires a corresponding increase in the intensity of planning. On the other hand, it has become clear in many countries that the effectiveness of several regional planning instruments has dropped considerably when used with greater intensity. For example, the Finnish report (Section 2.1 of Chapter 24) mentions a continuous increase of financial support for each job created. Of course, this may reflect not only decreasing returns to scale in the use of planning instruments, but also changes in general economic conditions. Yet it is clear that there are limits to the growth of intensity of planning and policy making.

What is beyond doubt is that the growing intensity of planning observed up to now has been a strong incentive for the development of regional information systems.

2.3. *Level of Centralization*

By dealing with the level of centralization, we focus on the vertical relationships between national, regional, and local authorities. A planning system is called centralized when the planning carried out at the national level restricts the feasible area for planning at the regional or local level to a large extent. The level of centralization varies with the planning component (Table 1 of Chapter 18), but it is in general higher in regional economic planning than in land-use planning. The ordering below gives a summary for the six countries across the various planning components that have been distinguished.



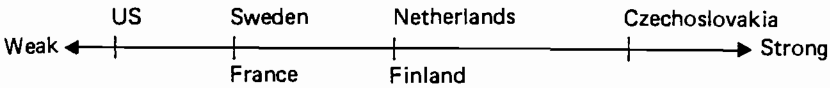
Level of centralization of regional planning.

In the US there is extensive scope for independent planning initiatives at the regional level. In France and Czechoslovakia the planning is highly centralized. The remaining three countries assume intermediate positions. A high degree of centralization does not necessarily imply that the planning is highly integrated, since in addition to vertical links, horizontal links (between planning components) have to be taken into account.

The national reports reveal that there is a tendency toward less centralized planning structures in France, the Netherlands, Sweden, and the US. We note that these are not only countries with a high prior level of centralization. Clearly, this tendency is a stimulus for the development of information systems at the regional and local levels.

2.4. *Coordination of Planning Components*

In addition to vertical links in planning, attention should be paid to the horizontal links, that is, the coordination of planning components at the national or subnational level. In the US regional planning is rather fragmented in this respect, whereas the planning system in Czechoslovakia gives the impression of being well integrated. In the Swedish and French reports mention is made of problems of coordination at the regional and local levels. Thus we arrive at the following ranking.



Degree of coordination of planning components.

Horizontal coordination gives rise to iterative procedures. Planning documents are produced in preliminary form and achieve their final form after agreements are made on adjustments (e.g. Figure 1 in the Finnish report, Chapter 24).

The reports are not very informative on the planning fields for which coordination is most urgent. The Swedish report mentions possible tensions between regional economic planning and transport planning. Also, conflicts between the preservation of the natural environment and economic development are noted. Coordination in these fields is certainly important for most countries and this is obviously not a complete list.

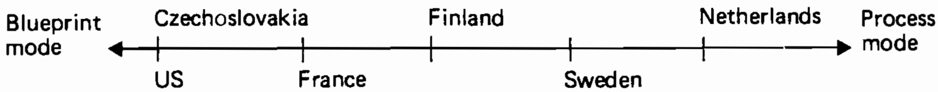
Conflicts have an important influence in both vertical and horizontal coordination. Dialogue and agreement, the main ingredients of the French planning system, are in general not sufficient to achieve coordination. Compromise after heavy bargaining or the imposition of a certain outcome by a competent authority is a usual feature of regional planning.

2.5. *Blueprint versus Process Planning*

When there is a low probability of unforeseen events, the preparation, decision, and implementation stages of planning can be carried out consecutively, giving rise to a so-called blueprint mode of planning (Faludi 1973). In uncertain environments this planning mode is unsatisfactory, however. Then, there is a need for a continuous check on how plans are functioning in practice so that it is possible to adjust policies in time. Such a mode of planning, in which the three above-mentioned activities are carried out simultaneously, is called process planning.

Which mode of planning is more appropriate depends on the planning field. Transport networks and other kinds of infrastructure usually have long-lasting effects (thirty years or longer). Once they are created, there is not much flexibility left to adapt them to new developments. For such planning components there is little scope for a process approach. In economic and land-use planning there are better opportunities for responding to unexpected developments. The time spans for these planning components as reported in the national studies are much smaller: approximately five years for regional economic planning and 10–15 years for land-use planning.

The extent to which the process mode of planning is prevalent in the various countries is shown by the following ranking.



Mode of regional planning.

The Dutch report indicates that monitoring plays an important role in the planning activities: there is a continuous check on whether intended and actual developments are in agreement (see also Chapter 5 by Brown). This is a clear indication of the process mode. A similar indication can be found in the Swedish report, which states that annual regional economic plans have replaced five-year plans. The ranking of the United States at the extreme of blueprint planning may be surprising, but one should be aware that infrastructure is an important planning component in this country. As noted above, planning of this component is usually carried out in a blueprint mode.

2.6. *Conclusion*

The results obtained in the previous sections are summarized in Table 1. Figure 1, which shows the same information, clearly reveals the extreme positions of the United States and Czechoslovakia. The elements in Table 1 will be denoted as a_{ij}, where i refers to the country ($i = 1, \ldots, 6$) and j to the planning feature ($j = 1, \ldots, 5$).

Table 1 Ranking of countries according to various features of their regional planning systems (highest rank is 6, lowest rank is 1).

Country	Scope	Intensity	Level of centralization	Degree of coordination of planning components	Planning mode: similarity to process planning
Sweden	2	3.5	3	2.5	5
France	5.5	2	5.5	2.5	3
United States	1	1	1	1	1.5
Netherlands	3.5	5	4	4.5	6
Czechoslovakia	5.5	6	5.5	6	1.5
Finland	3.5	3.5	2	4.5	4

Which countries have the most similar regional planning systems? This question is difficult to answer since the available information is only ordinal. On the basis of this information the most straightforward method would be to use the sum of the differences in ranks as a measure of dissimilarity:

$$d_{ii'} = \sum_{j=1}^{5} |a_{ij} - a_{i'j}| . \tag{1}$$

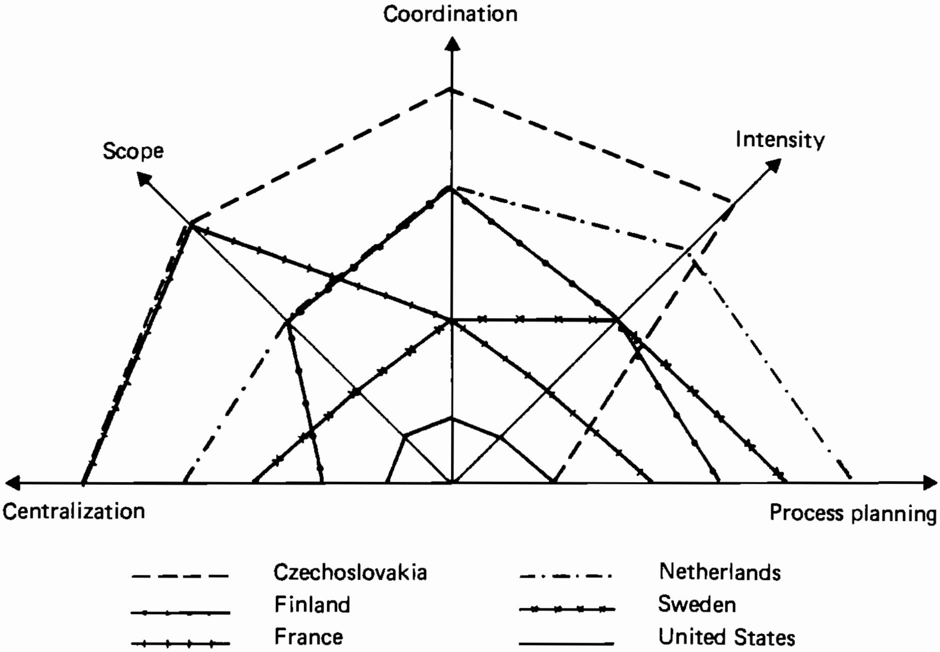


Figure 1 International comparison of features of regional planning systems.

Thus, if there were no ties, the minimum value of $d_{ii'}$ would be 5, indicating that i and i' are neighbors in all rankings. Table 2 contains the values of the dissimilarities for all pairs of countries. The contents of this table should be interpreted with care: they refer only to differences in ranks, which are not the same as differences on a cardinal scale.

The table shows that the United States and Czechoslovakia differ considerably from the remaining four countries. A clear cluster is formed by Sweden, Finland, and the Netherlands. France is difficult to classify: in some respects, its planning system is similar to the system in Czechoslovakia, while in other respects it resembles the systems in the other West European countries.

Table 2 Dissimilarities between the regional planning systems of countries.

	Sweden	France	United States	Netherlands	Czechoslovakia	Finland
Sweden	–	9.5	10.5	7.0	15.5	5.5
France	9.5	–	13.0	11.5	9.0	10.0
United States	10.5	13.0	–	17.5	19.0	12.0
Netherlands	7.0	11.5	17.5	–	10.5	5.5
Czechoslovakia	15.5	9.0	19.0	10.5	–	12.0
Finland	5.5	10.0	12.0	5.5	12.0	–

The information in Table 1 can also be used to analyze the interdependence between the features of regional planning systems. For this purpose we make use of a rank correlation coefficient developed by Kendall (1970). This coefficient is based on pairwise comparisons of observations (countries). When the rankings of a pair of countries by two variables point in the same direction, we speak of a *concordant pair*. For example, in Table 1, according to the first feature, France ranks higher than the US (5.5 > 1), which also holds true for the second feature (2 > 1). Hence, France and the US form a concordant pair for the first two features. In a similar way we speak of a *discordant pair* when the rankings for two countries point in opposite directions. For example, for the first two features in Table 1, France and the Netherlands form a discordant pair (5.5 > 2 and 3.5 < 5). If S^+ denotes the total number of concordant pairs and S^- the number of discordant pairs, then Kendall's rank correlation coefficient is defined as:

$$\tau^B = \frac{S^+ - S^-}{\left[(S^+ + S^- + T_x)(S^+ + S^- + T_y)\right]^{0.5}} \tag{2}$$

where T_x and T_y denote the number of pairs with equal ranks in x and y, respectively. It is not difficult to see that the extreme values that τ^B can assume are +1 and −1, so that τ^B is comparable with the ordinary Pearson correlation coefficient for cardinal data. If all correlation coefficients were equal to 1, Figure 1 would show six concentric pentagons.

Table 3 contains the rank correlation coefficients for the five features of regional planning systems distinguished in this section.

Table 3 Rank correlation coefficients for five features of regional planning systems.

		(1)	(2)	(3)	(4)	(5)
Scope	(1)	1.00	0.44	0.76	0.57	−0.15
Intensity	(2)	0.44	1.00	0.50	0.89	0.36
Centralization	(3)	0.76	0.50	1.00	0.44	0.07
Coordination	(4)	0.57	0.89	0.44	1.00	0.15
Planning mode	(5)	−0.15	0.36	0.07	0.15	1.00

The table contains positive and relatively high correlations between the first four features. The correlation between features 2 (intensity) and 4 (coordination) is particularly high. We may conclude from the table that in the various countries there is a certain balance between the scope of planning, the intensity of planning, the degree of centralization, and the extent of coordination of planning components.

The fifth feature (planning mode) displays low correlations with the other ones. Thus, in the various countries the choice of a blueprint or a process mode appears to be quite independent of the other features.

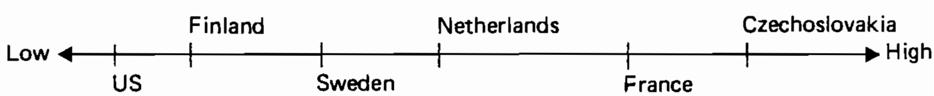
3. Comparison of Regional Information Systems

3.1. *Level of Centralization*

An information system is called centralized when a national agency is responsible for all elements involved: formulation of definition standards, data collection, data storage, data analysis and modeling, distribution of information, etc. In completely decentralized information systems these elements are dealt with by regional or local agencies. In the various countries, information systems with a centralized orientation coexist with less centralized systems. The national reports clearly show that the balance between both types varies among countries.

In the United States the share of decentralized information systems seems to be largest. This can be deduced from the fact that for most states regional economic models have been developed, something which cannot be said of the other countries. This strong decentralized orientation obviously reflects the predominant planning tradition in the US. It should be added, however, that the size of the country may have contributed to this outcome: the average size of the states in the US is much larger than the size of the regions in most other countries dealt with in this survey.

The national reports give the impression that regional or local initiatives in developing information systems are small in Czechoslovakia and somewhat larger in France. Some further steps toward decentralization have been taken in the Netherlands, Sweden, and Finland. Thus we arrive at the following ranking.



Level of centralization in information systems.

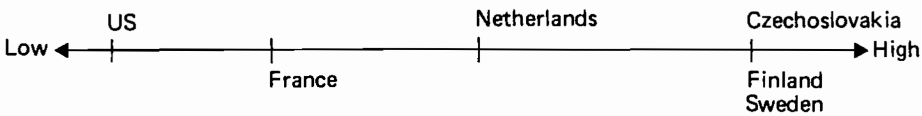
The technological developments of the last decade certainly provide opportunities for further decentralization of information systems. In a technological sense there are at present no barriers preventing this. Other barriers may still exist, however, such as limited budgets of regional and local authorities, insufficiently qualified staff at noncentral levels, and political unwillingness.

The proposal, contained in the Swedish report, to leave the main responsibility for deciding on definitions and for data collection at the central level, and to increase noncentral efforts in tabulation and analysis (including modeling), is certainly a feasible step toward decentralization. Such a step would considerably speed up the availability of regional data. For example, given the present centralized system in France, where the regional dimension does not receive great attention in the national agencies, regions have to wait an unnecessarily long time before these agencies produce regional tabulations.

There is a clear correspondence between the rank order obtained in this section and the order found for the level of centralization of regional planning systems (Section 2.3). This means that the vertical structure of a planning system is certainly reflected in the extent of decentralization of the pertinent information systems.

3.2. *Integration of Information Systems*

Having discussed the vertical aspects of information systems, we now turn to the horizontal aspects: the extent to which information systems give an integrated view of the various planning components. For an integrated view, the information produced should be coherent; that is, it should be synchronized and standardized. On the basis of the national reports we arrive at the following ranking.



Level of integration of information systems.

Sweden and Finland deserve special attention here because their information systems are to a considerable degree based on administrative register systems covering the total sets of statistical units (especially persons). Since every statistical unit (person) has an identification code, these registers can be linked to produce integrated information. This possibility of linking is clearly very attractive. However, the Finnish report indicates that a strong reliance on administrative registers also has disadvantages: the concepts used in these registers are not always suitable for research and planning.

The ranking shown above does not differ much from the ranking, in Section 2.4, dealing with the coordination of planning components. Only Sweden and the Netherlands have changed positions.

3.3. *The Role of Modeling*

Regional models have two possible functions in connection with regional information systems. They can be consumers of data produced by regional information systems, but they can also be integrated parts of information systems, producing forecasts or impact statements. It is the latter aspect that we will examine in this section.

A wide spectrum of models that are parts of information systems is mentioned in the national reports: demographic, labor market, transportation, input–output, and regional economic models. On the basis of the reports we conclude that the role of models in information systems is largest in the United States, followed by Sweden. In Finland, the role of modeling is very modest. The other countries assume intermediate positions.

Role of modeling in information systems.

The Swedish report gives information on the difficulties of using forecasting models in information systems. Planners at the regional level disagreed with regional forecasts produced by a multiregional economic model operated at the national level. The model was rejected as being too mechanical. Therefore, a plea is made for more flexible models. One should not expect, however, that the problem can be solved completely by introducing models that take into account behavorial elements so that they are more flexible. Some people even claim that behavorial models are not suitable at all for policy analysis since they contain many subjective elements (e.g. Spronk and Veeneklaas 1983). Because of these elements, the validity of such models can easily be questioned by each participant in the planning process who disagrees with the forecasts produced.

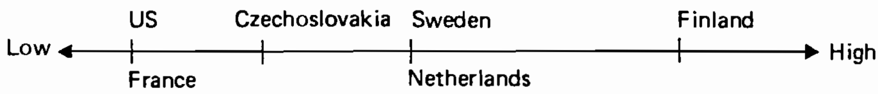
We conclude that for the use of models in regional information systems to be fruitful, much attention should be paid to model validity. It is disappointing to know, however, that the majority of operational (multi)regional models have not been subjected to rigorous validation tests (Rietveld 1982).

Models may be used not only for generating forecasts or impact statements but also for *ex post* evaluations of policies. Such evaluations are essential for determining the effectiveness of policy instruments. In the national reports this type of model use is not mentioned, clearly indicating that in planning insufficient attention is paid to the lessons that can be learned from the past. This conclusion is in agreement with earlier findings on *ex post* evaluations in regional planning (Nijkamp and Rietveld 1982).

3.4. *Regional Detail*

The appropriate regional detail in information systems obviously varies with the planning component and spatial level (see Table 1 of Chapter 18). For land-use planning at the local level, very high detail is necessary, whereas for regional economic planning such detail is both impossible and unnecessary. The following ranking gives an impression of the regional detail of economic data (production, employment, income, etc.) in the six countries surveyed. We have interpreted the size of regions in terms of population, not in terms of area.

In Finland, regional detail is high: data are available on the local or county level. In Sweden and the Netherlands the county or provincial level prevails, while in France and the United States the average size of the corresponding region is still larger. The position of Czechoslovakia is probably between the two pairs mentioned above. The rank order obtained by



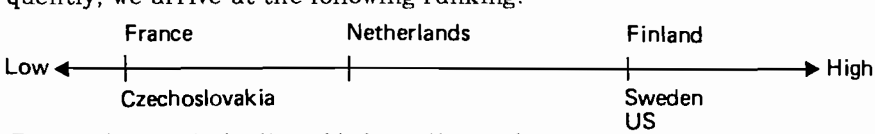
Regional detail in information systems.

this consideration runs parallel to a ranking of the countries according to population.

In almost all reports mention is made of the problems concerning confidentiality rules when information is produced at high levels of regional detail. These rules force one to produce output at a lower level of detail with respect to other features (for example, industrial classifications). Thus a trade-off exists between sectoral and regional detail. Although the alleviation of confidentiality rules is "an almost unanimous wish" (French report, Chapter 20), it is not probable that this wish will be fulfilled soon. Therefore, the development of methods to produce statistical information that obeys these rules with a minimum loss of information remains an extremely useful activity (see also Chapter 14).

3.5. *Extent of Computerization*

Computerization of regional information systems has increased rapidly. From the national reports it is clear that computerization has had its strongest effects in the throughput stage (data storage and data processing). The input stage has been computerized to some extent, especially in Finland, Sweden and the US where administrative registers are an important data source. The computerization of the output stage varies between countries. The reports from Finland, Sweden and the US explicitly mention on-line connections with major users. Since we are dealing with information systems in which the spatial dimension is essential, the production of cartographic output deserves special attention. This aspect is discussed most thoroughly in the Dutch report (Chapter 22). Consequently, we arrive at the following ranking.



Extent of computerization of information systems.

This is similar to the ranking obtained for the role of modeling (Section 3.3), with the exception of Finland. This indicates that a high level of computerization does not necessarily imply that modeling plays an important part in regional information systems.

3.6. *Weak Elements of Information Systems*

Before turning to a comparison of the results obtained thus far, we will first deal with some major bottlenecks in regional information systems mentioned in the national reports. The reports from France, the Netherlands, and Sweden contain complaints about the long delay before regional data become available. In these countries it is not unusual that the most recent data available for some key variables are already five years old. This is obviously a crucial disadvantage, which seriously limits the usefulness of regional information systems for planning and analysis.

Leaving aside the report from Czechoslovakia, which is not very informative in this respect, we note that in France, the Netherlands, and Sweden the level of centralization of the information systems is highest. Apparently, the priority given to producing recent regional information is low in these countries. It is not surprising, therefore, that in their national reports the decentralization of regional information systems is advocated.

Chapter 18 has already indicated that other kinds of delay may occur in information systems. A fundamental type of delay is the one between the recognition of a new policy problem and the implementation of a corresponding information system. It may take years before an appropriate information system has been developed. This aspect receives attention in the Finnish report, in the context of the energy problem.

The national reports reveal that interregional flows form a weak element in many information systems. This is not surprising, since data on interregional flows are of a more complex nature than other regional data: they refer to pairs of regions, and therefore they are more difficult to measure. These data are crucial for the understanding of the development of spatial information systems, since they describe interdependences in space and they are dynamic by nature. In the reports from Sweden, France, and the Netherlands, deficiencies in data on interregional trade are mentioned. In addition, problems with interregional migration are reported for France and the United States. Other interregional variables, such as money flows, are not mentioned in any reports, which probably means that they are not covered in existing regional information systems. The poorness of information systems in this respect has certainly had repercussions on the value of the analysis of multiregional systems (Issaev *et al*. 1982).

Another weakly developed element of regional information systems is formed by the almost exclusive concentration on "hard," numerical information. Qualitative data are left out of consideration. The Dutch report mentions two types of qualitative information: information about facts (e.g. approved policies, commitments made) and information about opinions (e.g. attitudes toward certain issues, satisfaction with public goods).

Information of this kind receives marginal attention in the reports from the Netherlands, Czechoslovakia, France, and Sweden, yet no one would claim that this kind of information is irrelevant for planning and policy making. It must be admitted that data of this kind are sometimes difficult to treat. It is important to note, however, that during the last decade substantial progress has been made in the development of methods for this purpose (Nijkamp *et al.* 1983). This progress has not yet materialized in regional information systems.

3.7. *Conclusion*

Table 4 summarizes the results from the preceding sections. The same information is contained in Figure 2. Comparing Table 1 with Table 4, we note that the position of Czechoslovakia is less extreme in the second table.

Table 4 Ranking of countries according to various features in their regional information systems (highest rank is 6, lowest rank is 1).

Country	Level of centralization	Level of integration	Role of modeling	Regional detail	Extent of computerization
Sweden	3	5	5	4.5	5
France	5	2	3	1.5	1.5
United States	1	1	6	1.5	5
Netherlands	4	3	3	4.5	3
Czechoslovakia	6	5	3	3	1.5
Finland	2	5	1	6	5

For a more detailed study of the differences between countries we have computed dissimilarities by means of equation (1). The results, presented in Table 5, clearly show that the situation in the United States is very different from that in the other countries. Further, it shows that the Dutch information systems are rather similar to those in the remaining countries. When one carries out a cluster analysis on the basis of this table, one arrives at one cluster consisting of Czechoslovakia, France, and the Netherlands and another cluster consisting of Sweden and Finland, although the dissimilarity between the Netherlands and the Sweden–Finland cluster is not large. This clustering differs from the clustering in Section 2.6 (based on similarities of systems). The main reason is that the difference between Czechoslovakia and the other European countries is larger with regard to their prevailing planning systems than with regard to their information systems.

Interdependences among the features of regional information systems can again be analyzed by means of rank correlation coefficients calculated using equation (2). The results are represented in Table 6. This table shows that there are two clusters of interdependent variables: (1,5) and (2,3,4). Concerning the first cluster, we remark that the negative correlation between computerization and centralization indicates that the possibilities for decentralization of information systems are best when the computerization of the information systems has proceeded further (or vice versa). The second cluster is more difficult to interpret. One would not expect a negative correlation between the role of modeling and the

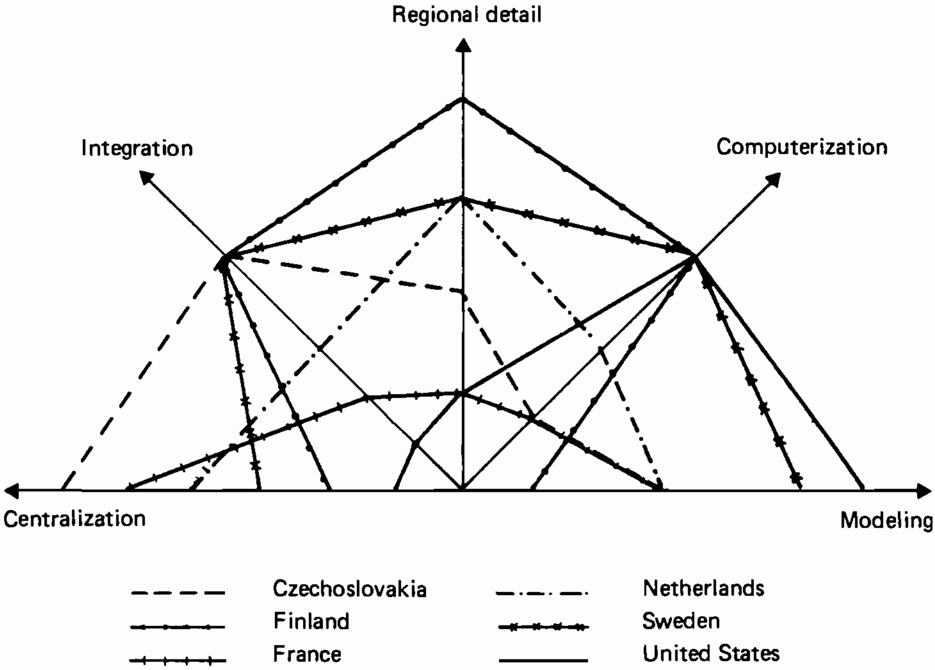


Figure 2 International comparison of features of regional information systems.

Table 5 Dissimilarities between the regional information systems of countries.

	Sweden	France	United States	Netherlands	Czechoslovakia	Finland
Sweden	–	13.5	10.0	7.0	10.0	6.5
France	13.5	–	11.5	6.5	5.5	16.0
United States	10.0	11.5	–	13.0	17.0	14.5
Netherlands	7.0	6.5	13.0	–	7.0	9.5
Czechoslovakia	10.0	5.5	17.0	7.0	–	12.5
Finland	6.5	16.0	14.5	9.5	12.5	–

level of integration of information systems, since coherent data are a prerequisite for regional modeling. As can be seen from Table 5, this negative correlation is caused by the deviating positions of Finland and the US. This result clearly shows that there is still much scope in several countries for increasing the role of models in regional information systems. The deviating position of Finland also explains why only a small positive correlation is found between the role of modeling and level of computerization.

Finally, Table 7 shows the results of an analysis of cross-correlations between features of regional planning systems and of regional information systems. As already noted, the correlation between centralization in information systems and centralization in planning is high, as expected. The

Table 6 Rank correlation coefficients for five features of regional information systems.

		(1)	(2)	(3)	(4)	(5)
Centralization	(1)	1.00	0.15	−0.30	−0.21	−0.86
Integration	(2)	0.15	1.00	−0.42	0.64	0.08
Role of modeling	(3)	−0.30	−0.42	1.00	−0.48	0.24
Regional detail	(4)	−0.21	0.64	−0.48	1.00	0.42
Computerization	(5)	−0.86	0.08	0.24	0.42	1.00

Table 7 Rank correlation coefficients between features of regional planning systems and of regional information systems.

Features of information systems	Features of planning systems				
	Scope	Intensity	Centralization	Horizontal coordination	Planning mode
Centralization	0.79	0.55	0.90	0.50	0.00
Integration	0.16	0.57	0.08	0.64	0.23
Role of modeling	−0.52	−0.39	−0.43	0.64	−0.23
Regional detail	−0.08	0.30	0.30	0.38	0.44
Computerization	−0.77	−0.86	−0.82	−0.42	0.16

same holds true for the correlation between horizontal coordination in planning and the integration of regional information systems. Low correlations are found for planning mode and regional detail. Also striking are the negative correlations between the role of modeling and the level of computerization, on the one hand, and several major features of regional planning systems on the other hand.

The conclusion is justified that the modeling and computerization aspects of regional information systems are underdeveloped in several countries, with respect to the high demands imposed by the structure of the regional planning system.

References

Faludi, A. (1973) *Planning Theory* (Oxford: Pergamon).

Issaev, B., P. Nijkamp, P. Rietveld, and F. Snickars (eds.) (1982) *Multiregional Economic Modeling: Practice and Prospect* (Amsterdam: North-Holland).

Kendall, M.G. (1970) *Rank Correlation Methods* (London: Griffin).

Nijkamp, P., H. Leitner, and N. Wrigley (eds.) (1983) *Measuring the Unmeasurable: Analysis of Qualitative Spatial Data* (The Hague: Martinus Nijhoff).

Nijkamp, P., and P. Rietveld (1982) Measurement of the effectiveness of regional policies by means of multiregional economic models. In B. Issaev *et al.* (1982), pp. 65–82.

Rietveld, P. (1982) A general overview of multiregional economic models. In B. Issaev *et al.* (1982), pp. 15–34.

Spronk, J., and A. Veeneklaas (1983) A feasibility study of economic and environmental scenarios by means of interactive multiple goal programming. *Regional Science and Urban Economics* 13 (1).

PART

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Information Systems for Integrated Regional Planning: A Synthesis

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CHAPTER 26

Information Systems: Retrospect and Prospect

Peter Nijkamp and **Piet Rietveld**

1. Relevance of Spatial Information Systems in an Era of Change

One of the most severe problems faced nowadays in many countries is the deeply felt impact of structural economic and technological changes taking place in circumstances of economic and sometimes demographic stagnation. Though it is not the first time since the Second World War that drastic economic and technological changes have taken place, there are significant differences between the present situation and the 1950s and 1960s (Robert 1982, Stern 1982):

- the current changes are taking place in an era of recession instead of growth;
- awareness of the negative spillover effects (e.g. distributional effects) of structural change is much higher;
- there is a much stronger institutional tendency to make comprehensive evaluations of long-term economic, social, and environmental impacts of these changes.

Consequently, without even considering their contents, information systems have to be used in an entirely different context. This means that not only must the state of a complex system be addressed by modern information systems, but so also must its structure (e.g. causality patterns), the conflicts generated by various plan alternatives, the uncertainties inherent in any structural change, the political nature of the planning process, and a simultaneous (often integrated) consideration of the (multidimensional) aspects of planning problems. This applies not only at the national level of economic, social, manpower, environmental, and financial planning, but also, more specifically, in the field of regional planning. Thus information systems for regional planning have to anticipate the consequences of the above-mentioned structural changes taking place at a more global level: for instance, industrial adjustment, regional labor market developments, distributional effects on declining and relatively prosperous areas, migration patterns, location trends of newly created activities, and impacts of automated and computerized production processes.

At the urban scale, similar changes are to be anticipated by appropriate urban information systems, such as decline and emergence of new industrial activities as a result of progress in microelectronics and telecommunications services, evolution of commuting patterns, changes in the structure and distribution of urban services, and changes in lifestyle (e.g. recreation).

Clearly, regional and urban planning is a multifaceted activity. Given the present issues in regional and urban planning, there is an almost infinite need for more and better data. Since in theory each policy aim would need its own specific data package, standardization of data is necessary in order to keep the costs of information provision within reasonable limits. This implies that sometimes the information provided will have a less precise focus, but it will have the advantage of greater consistency and comparability. Needless to say, the creation of such information requires close cooperation between statisticians, planners, researchers, and decision makers (Scheurwater and Masser 1983). More insight into experiences with regional information systems in different countries may thus facilitate the design of new information systems.

In the light of varying practices in spatially oriented information systems, international comparative research on the regional dimensions of information systems is an extremely valuable endeavor. This research may also demonstrate large regional variations in information systems

2. Scope of Information Systems for Regional Development Planning

It has already been stated in this book that information systems do not have particular aims in themselves, but are meant as an aid to solving complex decision problems. Information systems do not just include technical data, but provide a means for a well structured process of decision making. Consequently, information systems for regional planning should focus attention on the following issues (Nijkamp 1983):

- The development space of regional systems: this describes the set of all feasible states and demarcates the area within which policy choices are to be found.
- The set of key factors: key factors may be regarded as all forces that determine the movement of the variables in a system. These key factors may be distinguished as policy controls, encompassing all policy measures and instruments that serve to achieve a set of goals, and exogenous circumstances, indicating

all external factors that exert an impact on a system.

- The set of threshold factors: threshold factors describe the minimum conditions that have to be fulfilled before a certain takeoff or development of the system will actually take place (e.g. minimum accessibility). Threshold factors are closely related to the initial values of the state of the system.
- The set of initial values: this set indicates which alternative feasible combinations of variables are necessary before the system will move to a higher level of variables.
- The set of bottleneck factors: this set describes the critical levels of variables, beyond which the growth of a system will be hampered (e.g. congestion effects), leading to retardation of growth.
- The set of irreversible factors: this set indicates that for some variables and relationships the time trajectory is irreversible. Asymmetric behavior may lead to bifurcations or catastrophes (van Dijk and Nijkamp 1980).

The identification of the above-mentioned sets of variables would be a major contribution of information systems to strategic development planning of a system of a region. So far, these factors have received too little attention in information systems. A more distinct focus of information systems on these analytic issues would undoubtedly increase the utility of these information systems for regional development planning.

3. Spatial Orientation of Information Systems

The spatial orientation of many information systems, in general, is not very substantial. Two important problems should be mentioned here: spatial scale and spatial flows.

There is often a lack of agreement between the spatial scale of information systems and that of actual planning problems because of discrepancies between administrative (or legislative) and socioeconomic regional demarcations. Therefore, closer matching of information systems to administrative units is necessary. Given the multilevel pattern of regional decision making, it is in general an appropriate strategy to build information systems in a bottom-up fashion so as to let them fit flexibly into any desired level of regional planning and policy making (McDowell and Mindlin 1971). Computerized information systems (e.g. geocoding) may represent important progress in user-friendly data-processing activities, but it is at the same time clear that many efforts still have to be made before complex geographic processes (e.g. filtering processes) can be fully described and included in a scientific analysis. In general, a good geocoding system (or spatial reference system) is necessary to adapt information systems to the user's requirements. This implies that much attention has to be given to segment-based reference systems or refined grid (or zoning) systems in spatially oriented information systems for regional planning.

The second problem is the lack of information on spatial flows. These flows may be distinguished as either physical or nonphysical. In general, there is some information regarding physical flows (people, commodities, etc.), although we found in the preceding chapter that this information is not sufficient in several countries. However, as far as nonphysical flows (money, information, etc.) are concerned, there is a very serious lack of knowledge. Consequently, distributional impacts on the spatial equity of many public policy measures are very hard to judge. Especially noteworthy is the lack of information on money and finance in regional economies and regional planning, because in the early history of regional economies some attention was given to analysis of regional variations in spatial interest rates (Lösch 1954) and of spatial flows of funds (Isard 1960). The usual arguments are that money and financial capital are perfectly mobile, so that it suffices to focus attention only on the real side of the economy. As indicated by Karsch (1982), this view neglects the recent ideas developed in monetarism and neo-Keynesianism and fails to explain why regional unemployment is a result not only of long-term structural change, why capital mobility is induced not only by labor mobility, and why banking and finance tend to agglomerate in a few places.

Lösch (1954) has argued that regional disparities in finance may be due to asymmetric information structure. Consequently, the roots of the financial center hypothesis (in the Christaller framework) have to be found in spatially different information costs and mobility patterns of money. In this regard, there is a basic need for more appropriate interregional statistics on flows of funds.

4. Regional Accounts and Information Provision

In many countries, the dearth of regional data has precluded the construction of all but the most rudimentary models. Proposals for the development of systems of regional accounts often seem to stress data collection in terms of frameworks that have little relevance to many of the policy issues affecting regional and interregional development. Some of these issues are: (a) the handling of international impacts on the growth and development of regional systems; (b) the growth, distribution, and eventual consumption of nonwage and salary income (pensions, royalties, unemployment compensation, dividends, and other transfers); and (c) the handling of information on information flows *per se* in the economy, especially as they relate to the changing nature of control of productive resources in industrial systems.

A large number of regional and multiregional models have treated regions as analogous to "sheltered" enclaves embedded within national economies. International influences on the system are assumed to be filtered through some form of national-level screening process prior to affecting the regional economy. While such a modeling system may be defensible for countries like the United States with a considerable degree of internal self-sufficiency, it makes little sense to apply such thinking to the design of regional information systems for developing economies. The increasing internationalization of activities suggests that more thought should be given to data collection procedures that reflect these developments. The interaction between the international and the interregional economy needs to be considered more carefully – not only in terms of more traditional concerns with commodity trade but also with reference to international/interregional migration, information flows, capital movements, and so forth.

It has been observed (e.g. Batey and Madden 1981) that in a large number of regions, consumption of nonwage and salary income is rapidly becoming a significant feature of the driving mechanism in the regional economy. Increased mobility, particularly after retirement from the labor force, has engendered a new set of money flows in the interregional economy that are not subject to the standard economic modeling constraints. For several countries, as populations age, this feature is likely to increase. An associated problem, which, it is hoped, may be of shorter duration, concerns the dependence of some regions on government transfers (welfare payments and unemployment compensation). Taken together with the flows of dividends and royalties through the multiregional economy, we begin to appreciate that our accounting devices have been singularly lacking in their ability to handle these flows and their associated impacts. One set of accounts, the social accounting systems associated with Stone (1961) and subsequently Pyatt and Roe (1976), contains a feasible structure for handling such transactions. However, estimating the interregional components of these transfers may prove to be very difficult. Recent work by Hewings and Romanos (1981) and Hewings (1983) has suggested that the magnitude of consumption expenditure by households dwarfs in importance a large percentage of interindustry transactions. Yet, data on household consumption patterns are being collected in only a few countries.

The final issue on this topic concerns information itself: industrial systems geographers and regional scientists have become very interested in the spatial manifestation of phenomena such as product and process cycles, the "de-skilling" (Massey and Meagan 1979) of the labor force, and the changing control and ownership of capital in market economies. Many of our present regional information systems have been constructed on the assumption that the actors who were part of the industrial system belonged to a system characterized by tendencies toward perfect competition. In recent years, the empirical evidence suggests that the single plant owned by a local entrepreneur may become a thing of the past, as industrial restructuring moves increasingly toward ownership by larger corporations over many regions and nations. In many countries and regions, there is some concern about the potential impacts of "nonlocal" ownership of capital. How will regional economies fare in the future as this tendency increases? Will a new typology of regions emerge and on what basis will the distinctions be made? If we take a holistic view of regional systems, then what becomes most valuable for the purposes of data collection is the set of data that is *analytically* most important. A critical issue here revolves around the trade-off between completeness (which often involves collection of analytically insignificant data) and attention to the sets of data whose accurate estimation will contribute most to the successful use of regional information systems for a variety of purposes (Echenique 1983).

5. Integration of Information Systems

Information systems have often been designed for specific purposes: transportation data for transportation policy, housing data for housing market policy, etc. Clearly, there are various rational (institutional and technical) reasons why integration of information systems is hard to achieve (see Chapter 3). On the other hand, lack of integration means an enormous waste of effort. It would already be a significant step forward if national or regional bureaus of statistics were authorized to provide uniform rules for data collection and standard classifications for economic activities, even if it concerned information systems beyond the responsibility of these bureaus. Experience in technical and medical sciences has demonstrated the power of uniform rules and classifications, and there is no logical reason that would prevent the construction of a standard frame of reference for the design of more uniform spatially oriented information systems. This would also reinforce the weaker compartments of regional information systems, especially if a stepwise approach were adopted in the design of such systems (see also Chapter 8).

In addition, modern computer hardware and software facilities provide a great deal of possibilities for coupling different information systems. In this respect, public planning agencies may learn extremely useful lessons from multiplant and multiregional corporations, which have generally been able to solve the organizational problems of dealing with enormous, diversified data bases. The organizational aspects of internal communication within public agencies thus deserve much more attention. Modern (electronic) networks provide a huge potential for improving acquisition, communication, accessibility, efficiency, monitoring, and public participation in complex public choice situations. Similarly, the software facilities are as important as the information that will be produced by them (Schneider 1979, Olle *et al.* 1982).

Information systems are also a basic ingredient for regional planning models. Some of these models may be partial and simple, while others may be integrated and hierarchical (Issaev *et al.* 1982). Information systems should guarantee the appropriate use of data for such models, consistent linkage of submodels in a larger, master model, sufficient insight into causality patterns of complex systems, and a reliable impact assessment of the effectiveness of regional policy measures.

6. Locational Dimensions of Information Systems

The major part of the present study has been devoted to the relationship between information systems and regional development planning. It should be noted, however, that information systems not only are a tool in public policy, but may also act as a stimulus for regional and urban development processes. It has been argued by several authors (e.g. Thorngren 1970, Törnqvist 1970, 1975, Pred 1973) that information systems (contact systems, communication flows) may exert a significant impact on industrial location patterns, especially those of corporate organizations. Thus, though information systems are of major significance for regional and urban planning, they exert, at the same time, an impact on spatial developments *per se*.

Goddard (1975) has pointed out the impact of corporate organizations (especially when defined in terms of the location of nonmanufacturing functions and their information flow networks) on regional and urban development processes (e.g. through diffusion of technological innovation, polarized development, and regional external economies). The author concludes that the management of contact networks through investments in advanced telecommunications, communications audits, and the designation of growth centers based on information exchange functions can become an important policy instrument for both organizations and public sector agencies concerned with regional development. Thus, the contact pattern of multilocation, multiproduct corporate organizations has a significant impact on regional and urban growth processes and on the effectiveness of regional and urban policies. Communications audits administered by a public agency may become an appropriate tool in regional and urban policy by highlighting for firms opportunities for alternative locational/organizational arrangements, particularly the advantages to be gained through locating different but complementary functions in the same area.

One of the aspects that seem to be missing from many regional analyses is comparative evaluation of regional systems and how they have evolved. In our overriding concerns for completeness and accuracy, some broad-brush pictures of the regional system, its evolution, and likely future developments have been ignored. As a result, the division made between the need for policy analysis with partial or simplified models and the use of large-scale models for essentially scientific analysis has become a pervasive feature. A good illustration of finding a way out by creative thinking can be seen in the elegant model for regional growth and development articulated by Thompson (1965). Here, the author was able to describe the probable direction and character of a region's development in a way that any policy analyst could understand. Yet, behind this simplification was a rich conceptual framework drawing on the literature from economic base analysis and location theory.

In the last two decades, we have amassed a large collection of regional and interregional information systems. Unfortunately, our comparative analysis has tended to focus on the character of the *models* rather than on the *regions* they were representing. Are we able to say anything to policy analysts about the likely changes in the structure of spatial systems as we move from small, sparsely populated regions to larger ones dominated by metropolitan complexes? How do we expect these regions, at any spatial scale, to evolve? Jensen and Hewings (1983) approach these questions from the perspective of a holistic description of these systems, which attempts to transcend the gap between policy needs and scientific concerns. Such approaches may be extremely helpful in identifying the information really needed for regional analysis in the next several decades, as well as in analyzing the existing data systems in order that we can answer basic questions about structure and change in regional systems.

7. Demand for Qualitative Data in the Public Sector

Information systems derive a special meaning from the existence of a large public sector in many countries. If major parts of the economy are driven by nonmarket (e.g. public) factors, the market and price mechanism loses its importance. Hence, instead of money-oriented decisions, alternative frameworks of judgment have to be designed. Information systems may offer such frameworks, especially in the case of impact analysis for public policy decisions.

Information systems are also particularly important when there are conflicting policy issues with interest groups and citizen participation. Then, information systems do not serve to achieve an ambiguous policy solution, but to provide at least a platform for rational discussion based on facts.

Several of these issues are not quantifiable, but have a qualitative nature. Users, such as policy makers, are sometimes reluctant to include qualitative data in information systems, as they are regarded as inferior or subjective. This is by no means true, however. Qualitative data represent the *available* information on outcomes of a complex system, and it would be misleading to suggest cardinal values for variables (or proxies of latent variables) if the description of actual phenomena is indeed fuzzy or qualitative in nature (Adelman and Morris 1974, Nijkamp *et al.* 1983).

Modern information systems (such as decision support systems) are also able to include nonnumerical software, like reasoning, artificial intelligence, and a "natural" language interface. It has also to be emphasized that visual means (such as computer graphics) and analytic techniques (such as graph theory) are extremely important vehicles for integrating qualitative information in public decision-making practice (Sugiyama 1982).

Clearly, scientific analysis that is meant for realizing theoretical constructs should aim at defining variables and indicators in a precise way, but one has to be aware that often, for methodological or empirical reasons, many variables cannot be assigned a precise cardinal value. In this regard, an information system is only the tip of the iceberg, representing only part of a complex system. Clearly, the contents of an information system depend very much on the user's interest. Therefore, it would be worth while to encourage greater user participation in the design of information systems. The precise contents of such information systems will also depend on the social benefits of additional information and the social costs of insufficient information. As a result of the microelectronics revolution, the costs of processing data, even at an individual level, are declining very fast. Unfortunately, however, most bureaus of statistics are not very active in introducing new tools for data acquisition and processing so that the use of appropriate information for effective regional planning is far below its current potential. This also explains why the private market is increasingly taking over as the information processor for public planning.

8. Monitoring

Information systems for regional and urban planning deal with numerous economic sectors, areas, groups, periods, decision makers, and objectives. Each of these categories requires a specific content, structure, spatial scale, measurement level, and use of relevant information. Monitoring is often regarded as an important step toward a unifying methodology for reconciling the options related to such diverse interests. The question is, however, what the practical possibilities of coordinating complex, dynamic, multifaceted, and multilevel information systems are.

Monitoring is indeed a powerful planning instrument, especially if it is based on learning-by-doing principles. In this regard, it may be seen as a coordinative activity for harmonizing plan making and implementation (Verrijn Stuart 1976, Scheele 1983). Monitoring as such is not an entirely new planning tool, but it has only recently been given more considered attention. Nowadays monitoring provides a manageable means for interaction between the makers and the implementers of a plan, as it also involves an information-processing activity that registers the actual effects of the (potential) discrepancies between plan and implementation (see Chapter 5).

Monitoring is not valuable in itself, but has to be oriented toward sometimes unclear and inconsistent planning problems. Hence, diversity and flexibility are the usual attributes of any monitoring system, and such a system has to deal with both procedural and substantive issues. In this respect, monitoring is an important part of an interactive decision problem, to which the normal requirements for decision and methods apply (Chapters 1 and 2).

Monitoring is not only relevant in procedural planning, but it is also a valuable approach in *ex post* evaluation of policy decisions (see also Chapter 25). In particular, the measurement of the effectiveness of policy instruments may be facilitated if information is continuously available on both the expected impacts of changes in external conditions and the effects due to the implementation of policy instruments (Folmer 1983). Clearly, monitoring is not just a purely technical aspect of information systems: it is also part of an organizational learning procedure for regional and urban planning (Masser 1983).

9. The Time Dimension in Information Systems

The seventies have been marked by the recognition of a wide variety of new problems and policy issues (e.g. environmental and resource problems). Several policy goals appeared to be incompatible. It is equally probable that from the eighties will emerge new conflicting issues and options. Traditional information systems have hardly been able to deal with these new problems, as they were based on rigid, conventional ways of data collection and data processing. One may wonder whether it is possible to design information systems that could anticipate such new developments and what the basic features of such information systems should be.

The expected ability of information systems to cope with new policy problems and the need for continuous revision and improvement resemble the process of innovation and filtering in economic dynamics. New developments lead to speculation and the use of unvalidated statements. Then more claims for improvement of factual knowledge are made, leading to better established specific information systems. The anticipation of new future developments requires creative thinking about the contents and flexibility of information systems, as was shown by the need for energy statistics in the seventies.

The time dimension is indeed an underdeveloped aspect of spatially oriented information systems. There are only a few information systems able to disentangle short-term, medium-term, and long-term developments, and structural changes are very difficult to record in information systems. Consequently, changes due to drastic shifts in technology, in human behavior, or in institutional policies can hardly be covered satisfactorily by present-day information systems. This implies that the majority of information systems are more suitable for public management than for long-term, strategic decision making. The use of scenario analysis should be mentioned here, since it is able to take into account the basic uncertainty of the future by designing a set of alternative, reasonable, flexible, and well structured pictures of foreseeable developments. This would also require a more fundamental treatment of discount rates in regional planning issues. Further involvement of information systems with dynamic systems analysis and bifurcation (and singularity) theory might provide a more strategically based support for long-term policy and planning problems (Stöhr and Tödtling 1982).

Most planning information systems deal with quantitative data from the past. Much less attention has been given to qualitative information on future developments, though in scenario analysis substantial progress has been made (Figure 1). Also, citizen participation might be included more properly in the use of information systems for planning, since qualitative attitudes and opinions are not necessarily excluded by modern action-oriented information systems (e.g. early warning systems and decision support systems).

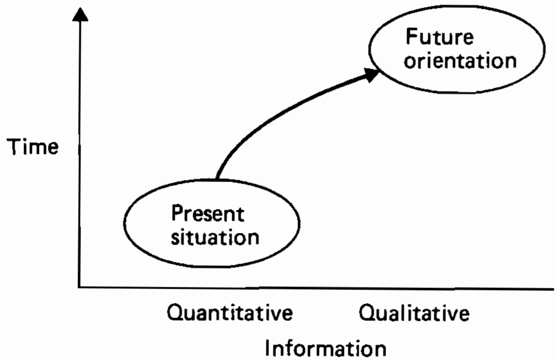

Figure 1 Orientation of planning information systems.

Apart from the strategic problems of including the time aspect in information systems, there is also another temporal flaw in many information systems. In general, the time between the moment of gathering data and the moment of publishing the resulting information by bureaus of statistics is extremely long (see Chapter 25). In many cases, it can be a decade before the information is made available to the public for scientific research. This regrettable situation is one of the causes of current criticisms of population censuses. It is therefore a necessity that modern hardware and software facilities be used from the beginning of a planning problem as integral elements of information systems.

In general, longitudinal and nonsurvey data as well as data from administrative registers may be a valid alternative to expensive census data (Guesnier 1980). A similar development can also be observed in the area of probabilistic disaggregate spatial choice models.

10. Confidentiality in Information Systems

Confidentiality provisions are one of the reasons why statistical data cannot be used completely. This is especially true for regional information systems, since data are presented at a lower level of aggregation and so the probability of disclosure is higher. It is thus important to examine what possibilities exist for relaxing confidentiality rules and which methods are most suitable for presenting statistical data so that they are as informative as possible without violating these rules.

Confidentiality problems are central to all information systems. Two possible reasons why confidentiality of data is often emphasized are that confidentiality may be necessary to avoid identification of individual characteristics, and that confidentiality of data gives the decision agencies a certain power, as it may increase their strategic position in complex choice situations and negotiations.

The latter reason has more to do with the creation of strategic uncertainty than with real confidentiality provisions. The first reason reflects a difficult compromise between usefulness of information and protection of individuals, firms, or agencies. To define an acceptable confidentiality level that does not preempt the disaggregate level of necessary information for effective regional planning is far from easy.

Confidentiality in statistics means that no individual item should be recognizable from the tables that leave the statistical office. This is a very important safeguard for the office itself because every disclosure of individual data may have its impact on the response rate and on the quality of the raw data. Respondents must be sure of the confidentiality of the information that they give to the statistical office. The confidentiality issue is closely related to legislation on the protection of privacy, which exists (or is being created) in many countries. According to such legislation, information obtained from an individual for certain purposes may not be used for other purposes (without his consent).

Although, in general, individual firms attach great importance to the confidentiality of data they give to statistical offices, usually the same data can also be obtained from annual reports of firms, internal news magazines, professional journals, and newspapers. Thus, the fear that competitors could derive too much information from individual data is, in general, unrealistic. Moreover, a good firm always has fairly accurate information about its competitors. Consequently, confidentiality provisions for individual business data may certainly be relaxed without doing any harm to individual firms. Many discussions on confidentiality of data tend to be more strategic in nature in negotiation processes, rather than concentrating on necessary statistical confidentiality.

The loss of information due to aggregation is an issue that has faced regional analysts but has never been attacked consistently on a broad scale. At base is the question of how confidential information about individuals or a firm might be used in the modeling process without betraying anyone's identity.

One way, which Leontief (1967) proposed, involves a simple partitioning of a matrix of information into "disclosable" and "nondisclosable" and the links between the two components. By standard matrix-partitioning procedures, a "reduced form" system can be obtained in which the disclosable set has been incorporated in the complete set of interactions in the economy.

An alternative, more "data-hungry" procedure, has been developed by Eliasson (1978). His micro-to-macro modeling system enables one to model small units, such as individual firms, using standard microeconomic theory. This structure is then cleverly embedded within a standard macroeconomic model. The quality of the latter is significantly improved without revealing any information about the microeconomic part of the model. Since many individual firms in an economy exert a significant influence on the growth and development of the regional system, this procedure may be a useful one to consider.

In the Leontief method, no distinction is made in the modeling of the individual as opposed to the aggregate: data routinely collected by census bureaus could be used in this fashion. In the Eliasson model, additional data of a far more confidential nature would be required. There are probably few countries where such data could be gathered on a wide enough basis to justify the effort involved. As indicated in Chapter 14, modern programming methods can be used to minimize the information loss due to confidentiality restrictions.

Altogether, the current strong emphasis on confidentiality is very much to the detriment of the design of useful information systems for regional planning. A reconsideration of confidentiality rules is undoubtedly a necessity.

11. Toward User-Friendly Information Systems

An information system should be versatile (i.e. accessible for various groups of users and for various objectives). The same information can be judged from many angles and so requires a specific presentation for a particular group (e.g. planners, model builders, systems analysts, statisticians, data-processing specialists, policy makers, and public interest groups). It is difficult to develop the desirable computer software that would allow information systems to be used for various purposes (including dialogue between users).

User-oriented information systems are necessary in order to improve communications between analysts and policy makers and to avoid a "black box" view of policy analysis and modeling. Modern communications and information technology offers many improvements here, since analytic tools can be made more accessible to policy makers through desk-top computer terminals and user-friendly software (e.g. interactive computer graphics). Recent developments in adaptive information systems have to be applied in regional planning in order to bridge the gap between information experts and responsible policy agencies (Mayer and Greenwood 1980, Sol 1983).

Our current information society needs rapid access to statistical information. Obstacles to obtaining appropriate data on time, and in usable forms, may be caused by basic data being unavailable (e.g. financial flows data) or by underutilization of existing data bases. An important lesson to be drawn from this situation is that more insight is needed into the appropriate design of information systems so that the actual use of information reaches its current potential. In the case of lack of data, it has to be emphasized that the widespread availability of computers today allows users to process statistical data themselves, as is reflected in the popularity of machine-readable data files. Furthermore, public agencies should be aware of a wide variety of data-finding aids, such as published catalogues, indexes, and table-finding guides, and computerized cataloguing and query systems (Sprehe 1981).

Clearly, the claims put on information systems for regional and urban planning may sometimes be too high, especially as far as the degree of comprehensiveness is concerned. It is uncertain whether information systems can be designed that show such a high degree of adaptability that they can deal with the dynamics of social change in a comprehensive manner. However, it may be worth while attaining a high degree of flexibility through *partial* information systems (e.g. focusing on a limited number of policy sectors). Recent developments in decision support systems and artificial intelligence indicate that modern computer technology (especially for data base management, data retrieval, and data display) offers many new opportunities for using adaptive information systems in a situation of socioeconomic dynamics (Banerji 1980). Consequently, rigid planning structures could be made much more flexible and better adjusted to the available information technology in order to improve the quality of decision making in today's complex society (see Chapters 16 and 17). However, a prerequisite for this to happen is the acceptance of the important position that modern information systems have in planning and policy making.

12. Conclusion

The implications of modern information technology for regional management and integrated planning may be far-reaching. Instead of early manual procedures (e.g. those based on encoding one grid cell at a time), there is now a strong tendency to use electromechanical and electronic digitizers. Automation of this field is proceeding rapidly, also implying that the creation of data files and the process of data gathering are taking place simultaneously.

Several kinds of scanning devices for acquiring information from maps of various kinds are now emerging. In addition, large data-sharing networks and the use of microprocessors are becoming more common. The development of modern hardware has led to the replacement of line printers by modern techniques, such as color graphics and electronic displays for graphic output. Data storage capacities have also been drastically improved, as is reflected in the design of modern data base management systems. Another development is the increased use of remote sensing for data gathering.

Thus altogether the increase in the speed of data file creation and of data processing in information systems for regional planning has been tremendous. This has obviously been helped greatly by the reduction in cost of many components of spatial information systems technology (e.g. for geocoding). In conclusion, the conditions are ripe for a further spread of spatial information technology.

It has to be noted that in the majority of countries regional information systems are not yet fully developed. The potential of modern information technology is much higher than its current use. This may be due to several factors, such as the expectation of high costs, lack of insight, institutional rigidity, and insufficient coordination. However, it should also be realized that a more adequate design and use of modern information systems for regional planning will lead to an improved quality of decision making and thus to higher social benefits.

References

Adelman, I., and C.T. Morris (1974) The derivation of cardinal scales from ordinal data. *Economic Development and Planning*, ed. W. Sellekaerts (London: Macmillan), pp. 1–39.

Banerji, R.B. (1980) *Artificial Intelligence* (Amsterdam: North-Holland).

Batey, P.W.J., and M. Madden (1981) Demographic–economic forecasting within an activity–commodity framework: Some theoretical considerations and empirical results. *Environment and Planning* A 13:1067–1083.

van Dijk, F., and P. Nijkamp (1980) Analysis of conflicts in dynamical environmental systems via catastrophe theory. *Regional Science and Urban Economics* 10 (4):429–451.

Echenique, M. (1983) The use of planning models in developing countries. *Urban and Regional Policy Analysis in Developing Countries*, eds. L. Chatterjee and P. Nijkamp (Aldershot: Gower).

Eliasson, G. (1978) A micro-to-macro model of the Swedish economy. *Report*, Bureau of Statistics, Stockholm.

Folmer, H. (1983) Measurement of effects of regional economic policy. *Ph.D. Dissertation*, Department of Economics, University of Groningen.

Goddard, J.B. (1975) Organizational information flows and the urban system. *Issues in the Management of Urban Systems*, eds. H. Swain and R.D. MacKinnon, pp. 180–225. *Collaborative Paper* CP-75-4, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Guesnier, B. (1980) Le système d'information régionale. *Revue d'Economie Régionale et Urbaine* 4 (2):1–20.

Hewings, G.J.D. (1983) Regional and interregional accounting systems for development planning under conditions of limited information. *Urban and Regional Policy Analysis in Developing Countries*, eds. L. Chatterjee and P. Nijkamp (Aldershot: Gower).

Hewings, G.J.D., and M.C. Romanos (1981) Simulating less developed regional economies under conditions of limited information. *Geographical Analysis* 13:373–390.

Isard, W. (1960) *Methods of Regional Analysis* (Cambridge, MA: MIT Press).

Issaev, B., P. Nijkamp, P. Rietveld, and F. Snickars (eds.) (1982) *Multiregional Economic Modeling: Practice and Prospect* (Amsterdam: North-Holland).

Jensen, R.C., and G.J.D. Hewings (1983) Holistic matrix descriptors of regional systems. *Report*, Department of Geography, University of Illinois, Urbana, IL.

Karsch, C. (1982) Flow of funds by state for Austria. *Report*, Department of Economics, University of Vienna.

Leontief, W.W. (1967) An alternative to aggregation in input–output analysis and national accounts. *Review of Economics and Statistics* 59:412–419.

Lösch, A. (1954) *The Economics of Location* (New Haven, CN: Yale University Press).

Masser, I. (1983) Organizational learning in urban planning: Two case studies of monitoring. *Evaluating Urban Planning Efforts: Approaches to Policy Analysis*, ed. I. Masser (Aldershot: Gower) (forthcoming).

Massey, D., and R. Meagan (1979) The geography of industrial reorganization. *Progress in Planning* 10:155–237.

Mayer, R.R., and E. Greenwood (1980) *The Design of Social Policy Research* (Englewood Cliffs, NJ: Prentice-Hall).

McDowell, B.D., and A. Mindlin (1971) Obtaining metropolitan planning data from local governments. *Journal of the American Institute of Planners* March, pp. 111–115.

Nijkamp, P. (1983) Technological change, policy response, and spatial dynamics. *Evolving Geographical Structures*, eds. D.A. Griffith and T. Lea (The Hague: Martinus Nijhoff).

Nijkamp, P., H. Leitner, and N. Wrigley (eds.) (1983) *Measuring the Unmeasurable: Analysis of Qualitative Spatial Data* (The Hague: Martinus Nijhoff).

Olle, T.W., H.G. Sol, and A.A. Verrijn Stuart (eds.) (1982) *Information Systems Design Methodologies* (Amsterdam: North-Holland).

Pred, A. (1973) *Urban Growth and the Circulation of Information* (Cambridge, MA: Harvard University Press).

Pyatt, G., and A.R. Roe (1976) *Social Accounting for Development Planning with Special Reference to Sri Lanka* (Cambridge, UK: Cambridge University Press).

Robert, J. (1982) Current research trends in the European countries: Premises for transnational and comparative urban and regional research. *Applied Urban Research*, eds. G.-M. Hellstern *et al.* (Berlin: Zentralinstitut für Sozialwissenschaftliche Forschung, Freie Universität), pp. 67–73.

Scheele, R.J. (1983) Making plans work. *Ph.D. Dissertation*, Department of Geography, University of Utrecht.

Scheurwater, J., and I. Masser (1983) An information analysis system for spatial planning in the Netherlands. *Social Science Information Studies* 3:95–107.

Schneider, H.-J. (ed.) (1979) *Formal Models and Practical Tools for Information Systems Design* (Amsterdam: North-Holland).

Sol, T.W. (ed.) (1983) *Processes and Tools for Decision Support*. Proceedings of Joint IFIP/IIASA Working Conference, International Institute for Applied Systems Analysis, Laxenburg, Austria (Amsterdam: North-Holland).

Sprehe, J.T. (1981) A federal policy for improving data access and user services. *Statistical Reporter* March, pp.323–341.

Stern, B.T. (ed.) (1982) *Information Innovation* (Amsterdam: North-Holland).

Stöhr, W., and F. Tödtling (1982) Quantitative, qualitative, and structural variables in the evaluation of regional development policies in Western Europe. *Report*, Interdisciplinary Institute for Physical Planning, University of Vienna.

Stone, R. (1961) *Input–Output and National Accounts* (Paris: OECD).

Sugiyama, K. (1982) Drawing and understanding systems structures: An introduction to the sketch system. *Working Paper* WP-82-97, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Thompson, W. (1965) *A Preface to Urban Economics* (Baltimore, MD: Johns Hopkins University Press).

Thorngren, B. (1970) How do contact systems affect regional development? *Environment and Planning* 2:409–427.

Törnqvist, G. (1970) *Contact Systems and Regional Development*. Lund Studies in Geography, Series B, No. 35 (Lund, Sweden: University of Lund).

Törnqvist, G. (1975) Spatial organization of activity spheres. *Issues in the Management of Urban Systems*, eds. H. Swain and R.D. MacKinnon, pp. 226–265. *Collaborative Paper* CP-75-4, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Verrijn Stuart, A.A. (1976) *Kwantitatieve Aspecten von Informatiesystemen* (Alphen aan den Rijn, Netherlands: Samson).

THE CONTRIBUTING AUTHORS

Dr. Peter Batey
Department of Civic Design
University of Liverpool
Abercromby Square
PO Box 147
Liverpool L69 3BX
England

Dr. Giuliano Bianchi
Istituto per la Programmazione
Economica della Toscana
(IRPET)
Via la Farina 27
I-50127 Florence
Italy

Dr. Peter Brown
Department of Civic Design
University of Liverpool
Abercromby Square
PO Box 147
Liverpool L69 3BX
England

Professor Raymond Courbis
Groupe d'Analyse Macroéconomique
Appliquée (GAMA)
Centre National de la Recherche
Scientifique
Université de Paris – X – Nanterre
2, Rue de Rouen
F-92000 Nanterre Cedex
France

Dr. Antonin Drozd
Deputy Director, Research
Institute for Development
of Cities and Districts
Ostrava
Czechoslovakia

Dr. Pavol Dujnic
Computing Research Center
Dúbravská 3
84221 Bratislava
Czechoslovakia

Dr. Jan van Est
Research Center for Physical
Planning (TNO)
PO Box 45
Delft
Netherlands

Dr. Daniel Garnick
Director, US Department of
Commerce
Bureau of Economic Analysis
Washington, DC 20230
United States

Dr. Gösta Guteland
Statistikutredningen
Fredsgatan 6 4tr
S-1152 Stockholm
Sweden

Dr. Björn Hårsman
Stockholm Regional Planning Office
PO Box 7841
S-10298 Stockholm
Sweden

Dr. Edwin Hinloopen
Department of Economics
Free University
Postbus 7161
NL-1007 MC Amsterdam
Netherlands

Professor Boris Issaev
(deceased)
Former Leader, Integrated Regional and Urban Development Group
International Institute for Applied Systems Analysis (IIASA)
A-2361 Laxenburg
Austria

Dr. Olli Janhunen
Planning Officer, Central Statistical Office
PO Box 504
SF-00191 Helsinki
Finland

Professor Börje Johansson
Acting Leader, Integrated Regional and Urban Development Group
International Institute for Applied Systems Analysis (IIASA)
A-2361 Laxenburg
Austria

Professor T.R. Lakshmanan
Chairman, Department of Geography
Director, Center for Energy and Environmental Studies
648, Beacon Street
Boston, Massachusetts 02215
United States

Professor Bertil Marksjö
Commonwealth Scientific and Industrial Research Organization (CSIRO)
Division of Building Research
PO Box 56
Highett
Victoria 3198
Australia

Dr. Jean Muguet
2, Rue du Clos Adrien
F-8700 Limoges
France

Professor Peter Nijkamp
Department of Economics
Free University
Postbus 7161
NL-1007 MC Amsterdam
Netherlands

Dr. Ola Nygren
Statistikutredningen
Fredsgatan 6 4tr
S-1152 Stockholm
Sweden

Dr. Aribert Peters
Bundesforschungsamt für Landeskunde und Raumforschung
Am Michaelshof 8
D-5300 Bonn 2
Federal Republic of Germany

Dr. Piet Rietveld
Department of Economics
Free University
Postbus 7161
NL-1007 MC Amsterdam
Netherlands

Dr. Annemarie Rima
Department of Economics
Free University
Postbus 7161
NL-1007 MC Amsterdam
Netherlands

Dr. Jan Scheurwater
National Physical Planning Agency
Blijmarkt 20
PO Box 502
8000 AM Zwolle
Netherlands

Dr. Dusan Slimak
Research Institute of Regional
Economic Planning
Drienova 34
829 80 Bratislava
Czechoslovakia

Dr. Frans de Vroege
Research Center for Physical
Planning (TNO)
PO Box 45
Delft
Netherlands

Dr. Folke Snickars
Expertgruppen för Forskning om
Regional Utveckling (ERU)
Ministry of Industry
S-10333 Stockholm
Sweden

Dr. M. Ramsay Wigan
Australian Road Research Board
PO Box 156
Numawading 3131
Victoria
Australia

Dr. Henk Voogd
Department of Civil Engineering
Delft Technical University
Delft
Netherlands

AUTHOR INDEX

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