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PERFORMANCE INDICATORS WITHIN A MODEL-BASED APPROACH TO URBAN PLANNING

G.P. CLARKE AND A.G. WILSON

School of Geography
University of Leeds
Leeds LS2 9JT

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1 Introduction

The aim of this paper is to develop a framework for the conceptual identification and calculation of performance indicators for use in a variety of situations in urban planning and policy analysis. We are particularly interested in the contribution urban modelling can make to the task, not for its own sake, but because we feel that concepts from that field can make the theory of performance indicators more effective and can extend the information system base which is necessary for their calculation.

Over the last thirty years, there has been a continuing interest in the task of defining indicators which would measure 'quality of life' in various ways and which could be used in urban planning and policy analysis. The intensity of interest has fluctuated and in recent years has waned. It has seemed that early promise has not been fulfilled, either from inability to provide the information base for the calculation of indicators or through relative lack of interest in planning by many government agencies of the late 70s and the 80s relative to the 60s and early 70s. However, interest has started to increase again from a new perspective: the possibility of measuring efficiency of performance in public services and nationalised industries, a notable current example being in the field of health policy (DHSS 1984). What we show in this paper is that many of the conceptual and data problems which have bedevilled earlier attempts can now be solved - in part using concepts from the field of urban modelling, and this opens the way for wide-ranging applications in a variety of specific fields and comprehensively.

However, it is important that these new ideas should be related to, and built on earlier work. The first two major parts of this paper are therefore devoted to a review of this earlier material. In section 2 we review the indicator movement from its earliest origins in the 50s and 60s. In section 3, we show how those planners who used urban models in the 60s and 70s developed concepts which can be interpreted as performance indicators. In section 4, we then show how recent developments in modelling and in the geographical understanding of the concept of performance indicators can be used to establish a powerful new framework. This embraces both the idea of

effectiveness of services and facilities 'delivered' to the population and that of the efficiency of organisations which supply these (whether public or private). In other words, it is possible to combine an interest in social indicators as represented in the early history of the indicators movement (see especially section 2 below) with the contemporary interest in efficiency.

The review here is deliberately wide-ranging to encompass many different styles of application. Some (arbitrary) cut-off points are necessary even so and therefore signposts to other references are included in the hope that the interested reader can find sufficient material to begin his or her own search if required: the review should function as a bibliographic source in its own right.

2. The indicator movement: a review and appraisal

2.1 Introduction

The aim of this section is to provide a broad review of the way in which geographers, economists and planners, in particular, have drawn upon a wide range of indicator-based studies to aid the identification of problem areas and examine the impact of possible alternative scenarios for development. We begin with the social indicator movement as it developed in the USA and then in the UK; this being the starting point for many subsequent deprivation or malaise studies. We also examine the development of the indicator movement by focussing attention on a wide range of different types of social and economic indicators applied at a number of different spatial scales, some of which predate the main social indicator movement. In section 3 we investigate indicator concepts in model-based urban planning. We show in section 4 that a full marriage of contemporary modelling ideas and the concepts of performance indicators can be very fruitful.

2.2 Social indicators in the US

Great concern was being voiced in the United States during the 1960s about the lack of information on the social well-being of American individuals. Pure economic indices or indicators had been available for some time, often published annually in the form of Government reports. Whilst these were generally regarded as being useful and informative, many commentators were concerned about the lack of similar indicators of social malaise. The US Department of Health, Education and Welfare (1969) remarked:

> "It seems paradoxical that the economic indicators are generally registering continued progress - rising income, low unemployment - while the streets and the newspapers are full of evidence of growing discontent - burning and looting in the ghetto, strife on the campus, crime in the street, alienation and defiance among the young." (p xi)

Such feelings resonate in many contemporary situations. Research into social indicators was initiated primarily by NASA, who were concerned over the impacts, or secondary effects, of the space programme on American society. Indeed the first major book on social indicators (Bauer (ed) 1966) was financed by NASA, and this represents the initial drive for more accurate social reporting. At the same time, a former senator (and indeed recent Presidential candidate!) was putting forward his support for more information on social well-being (Walter Mondale 1967a, 1967b). In Mondale (1967b), he describes the proposal for the 'Full Opportunity and Social Accounting Act' which called for a Council of Social Advisers, with a joint congressional committee to carry out the social accounting, and an annual social report. Similar conclusions and recommendations were reached by the National Academy of Sciences' Social Science Research Council (1969) who called for improved social indicators that would measure the quality of life, particularly in its non-economic aspects:

> "The Committee recommends that substantial support, both financial and intellectual, be given to efforts under way to develop a system of social indicators and that legislation to encourage and assist this development be enacted by Congress." (p 6)

The Johnson Administration contributed significantly to the indicator movement with its publication 'Towards a Social Report' (US Department of Health, Education and Welfare 1969). Smith (1973) notes that this report represents the first real attempt to produce a social equivalent of the US annual economic reports. The basic aim of the Report was to produce a set of social indicators, including health and social mobility, to 'satisfy our curiosity about how well we are doing'. (p xii)

Following Johnson, the Nixon Administration produced the National Goals Research Staff Report (1970) aimed at monitoring key goals or targets by selected indicators. After this, national Government reports were much less common. The major exceptions however were the two substantial reports of the US Office of Management and Budget, 'Social Indicators 1973' and 'Social Indicators 1976'.

However, a great deal of work had also been undertaken by other agencies and by many academics. For example, the Russell Sage Foundation commissioned the work of Sheldon and Moore (1968) which was concerned with sociostructural 'objective' indicators of social change, and Campbell and Converse (1972), concerned with psychological or 'subjective' indicators of attitudes, expectations, aspirations and values (Carley 1981). (See section 2.6 for more discussion on objective and subjective indicators)

Like any major new avenue of research these early developments took place without a universally agreed definition on what a social indicator was or ought to be. Indeed even today there is a wide variety of different interpretations and definitions (see Carley 1981-Ch 2). Johnstone (1981) defines an indicator in very general terms:

> "It should be something giving a broad indication of the state of the situation being investigated. It does not necessarily do this with a high degree of scientific exactness but it does indicate the general state of what is being examined." (p 3)

Some authors however stress the importance of defining an indicator within a broader framework, as part of a 'conceptual system of social processes' (Land 1971) or more generally within a wider information system (eg Carlisle 1972). These wider definitions will be elaborated in later sections.

With such abroad field of study it is perhaps reasonable to suggest a universal definition will never be reached. Edwards (1975) for example, calls for an 'operational' definition:

> ". . . not something on which consensus will ever be achieved - and nor should it be. Rather, it is a matter of stating clearly any value judgements implied, 'nailing one's colours to the mast' and producing a definition." (p 283)

2.3 The UK experience

It is widely agreed that the development of social indicators in the UK was very slow until the publication of the first volume of 'Social Trends' in 1970, when the idea of using informative indicators of social conditions received official sanction (Bracken 1981). The history of this publication is reviewed in Thompson (1978) and Carley, (1981, p 114 - 117).

One of the first major UK studies was that of Shonfield and Shaw (eds, 1972). The collection of papers in this book provide an excellent introduction, not only to the general issues and terminology of social indicators, (especially the papers of Cazes and Carlisle), but also in relation to specific sub-systems. Indeed the flavour of the social indicator movement can be tasted from a couple of examples within different sub-systems.

Work on indicators of education systems actually began in the late 1960s (Cohen 1967, Coombs 1969, Ferriss 1969). Ferriss for example, was convinced that serious planning of the education system should

always be accompanied by the development or use of indicators measuring the degree to which the goal of a plan is achieved, (1969 p6). Little and Mabey (1972) examined the field of education in the book by Shonfield and Shaw. They constructed an index for designating educational priority areas using such indicators as teacher turnover rates, ability of children to speak English adequately, proportion of retarded,disturbed or handicapped pupils, poor attendacy rates, truancy rates etc: all criteria originally recommended by the 'Plowden Report' (1967) in relation to the need for public intervention in favour of areas where educational handicaps were reinforced by social handicaps.

The most detailed work to date on indicators in the eduction system comes from the work of James Johnstone (eg, 1978, 1981). He, like Ferriss, is in no doubt as to the power or potential of an indicator-based approach:

> "In whatever form they are used, indicators have a real part to play in planning education system provision. Their potential contribution is that they can force planners, policy makers and politicians to state with more precision what future situations should be like. Without this precision, planning will continue to be as ineffective as it has been so often in the past". (1981, p. 8)

The kind of indicators Johnstone proposes are shown in Fig. 1: 'process indicators' for use in planning, monitoring and researching national education systems. (Johnstone also has a rather amusing method of presenting some of his indicators: the 'facial feature' method depicted in Fig. 2).

A second area where indicators have found considerable attention has been that of health care systems. Goldacre and Griffin (1983) provide an extensive review of indicators (and key statistics) in health care planning and remind us that as early as 1732, Dr. Clifton, writing in 'Lancet' and Florence Nightingale in the mid nineteenth century, were suggesting that certain items of data about all hospital inpatients should be systematically recorded,analysed and published to enable the work undertaken by hospitals to be assessed. Out of a plethora of references reviewed by Goldacre and Griffin, the work of Logan et al (1972) provides 'one of the most comprehensive

ranges of statistical indicators in the published literature'. The paper compared health services in Liverpool with those elsewhere, concentrating on a wealth of resource measures and activity measures. Fig. 3 lists the sort of indicators used in measuring activity rates, for example. This example illustrates a further geographical problem to which we will return: many of the indicators calculated involve ratios which must be modified to take account of cross-boundary flows.

This kind of research is couched in terms of system performance and paves the way for more formal consideration of performance indicators in section 2.5.

2.4 Issues of space and scale

2.4.1 Background

The drive to focus more specifically on social indicators in a geographical context came from the work of David Smith. He recognised that advocates of social indicators had rarely been geographers and were typically not accustomed to thinking in spatial terms. Interestingly he reflects:

> "It is the lack of maps more than any other thing that brings home to a geographer the very limited spatial perspective of the social indicators movement." (Smith 1973, p 65)

Smith adopted the phrase 'territorial social indicators' to examine explicitly the role of space in social indicator studies. Working primarily in the United States at first he and his colleagues looked at the social 'well-being' of various cities. These kind of studies will be dealt with in section 2.4.3.

Whilst a geographer, David Smith, introduced the terminology of the territorial social indicator, Knox (1975) makes an important observation:

> "Territorial social indicators are not merely a product of the geographers' perspective on the general social indicator movement; they are a necessary and logical extension of any realistic system of social reporting. People live locally and experience the prosperity, stresses, expectations and satisfactions of their own locality. National social indicators are aggregates of these conditions and as such may mask important problems at the local level." (p 11)

Apart from the explicit concern with space both Smith and Knox highlight the important different spatial scales of resolution. In relation to territorial social indicators, Smith (1973) comments:

> "It subsumes the concepts of 'local', 'regional', 'metropolitan' and 'urban' indicators, each of which can be regarded as a special category of territorial indicators." (p 63)

It is worth examining the use of social or territorial indicators at each of these spatial scales, some of which pre-date the general social indicator movement.

2.4.2 International studies.

Smith (1977) claims the first major attempt in geography at a sophisticated empirical analysis of different national levels of development came from the work of Brian Berry (1960, 1961). Berry was concerned with economic development in 95 different countries, measured in respect to 43 variables (Fig. 4). From these variables he distilled certain 'basic patterns of national variation' using the procedure of 'principal component analysis' (see section 2.4.4). The strongest of the components was the 'technical scale' which Berry reported to account for 84% of all the variance in the data matrix. Basing his analysis on this single composite index he was thus able to rank the 95 countries accordingly.

One of the most comprehensive studies of the 1960s was that of Bruce Russett and his colleagues in 1965. They produced the 'World Handbook of Political and Social Indicators' designed to compare human resources, economic development, levels of Government intervention, communications, health, education, family and religion across the countries of the world. An interesting indicator of health care, for example, was the number of inhabitants per physician.

Thus the countries of the world were ranked according to their 'score'. It seems tragically ironic today to learn that Ethiopia recorded the worst score, 117,000 inhabitants per physician (1956 data), as against the best for Israel of only 400 inhabitants (1960). These compared with 935 inhabitants per physician for the UK (1960) and 780 for the USA (1961). Taylor and Hughes compiled a second edition of the 'World Handbook' in 1972.

Many similar studies followed in the 1970s. McGranahan et al (1970) constructed a general composite indicator incorporating both economic and social aspects of development for 115 countries. Forty-two variables, based on the UNRISD data bank for 1960 (United Nations Research Institute for Social Development, 1969), were chosen to reflect a balance between social and economic indicators and between structural and development indicators. (McGranahan et al, 1970 p 54). King (1974) also produced a set of indicators to measure 'social progress', incorporating a time-comparison into his analysis (1954 and 1969), (see fig. 5), whilst the World Bank (1979) produced an extensive study of health-related indicators for both the poorest and richest countries of the world.

International comparisons do not necessarily involve a large number of countries. There is indeed a sizable literature on international comparisons involving a small number of countries. O'Loughlin (1983), for example, investigates the different levels of well-being in Germany and the USA whilst Scheer (1980) provides an international 'quality of life' comparison of fifteen OECD countries. Scheer adopts an interestingly simple philosophical approach when applying his set of indicators: they were nothing more than indicators to help isolate 'trouble spots' with the hope that attention could then be focussed on those problems, before they reached still greater proportions. (Scheer 1980, p 153)

2.4.3 National and regional studies

In section 2.2 we saw that much of the early work on social statistics and indicators in the USA was aimed at the national or regional scale. A similar pattern is identifiable for the UK.

Two studies are particularly worthy of note since they also provide early examples of 'multivariate analysis' (see also section 2.4.4). Buckatzsch (1946) examined data relating to income, unemployment, housing conditions and social class composition for a variety of UK County Boroughs (1941 data), whilst Moser and Scott (1961) were concerned with the way in which British towns and cities differed from or resembled one another. For a number of towns with populations over 50,000, they examined 57 variables based on population size and structure, population change, households and housing, economic character, social class, voting characteristics, health and education. A correlation matrix was established by using the 'product moment correlation coefficient' for all the variables taken in pairs. From this matrix fourteen groups or classes of town were identified, such as 'seaside resorts', 'textile centres', 'newer industrial suburban towns' etc.

Interest at this meso-scale appears again in many studies throughout the 1970s and early 1980s. Ross et al (1979) provide one of the most extensive US studies whilst Zapf (1980) examines the quality of life in West Germany between 1955 and 1975 using the 'SPES Indicator Tableau'(1976). The "abridged" version of this contains 196 indices all of which are shown in Fig. 6. In the UK the Ministry of Housing and Local Government (1970) examined regional comparisons in the standard of living in England and Wales using 68 variables of social and economic well-being. (See also Knox 1974a, 1974b).

It is, however, the comparison of different cities across a country that has received most attention since 1970, especially in the US literature. As Murphy (1980) notes, urban indicator research is simply an off-shoot of the social indicator movement, seeking to describe the social, economic and political conditions of Metropolitian areas in particular. He, and also Flax (1978), provide a bibliography of a wealth of such urban indicator studies.

Lewis (1968) very much set the standard with a study which ranked the best and worst cities in the US on a variety of indicators. The strategy was to be widely copied over the next few years. Louis (1975) and Liu (1975) for example both undertook similar strategies. Todd (1977) examined 100 major cities using a set of 80 key

indicators (see Fig 7). The aim of Todd's study was typical, simply to provide a yardstick with which to compare conditions in one city with those in other cities (p 1).

Jones and Flax (1970) compared Washington DC with 17 other major metropolitan areas for a variey of selected indicators. In order to look at the social conditions within Washington they divided the city into 14 areas and examined the 'quality of life' in each. Such detailed studies of areas within cities takes us into a new scale or level of resolution. It is to this large literature that attention now turns.

2.4.4 Intra-urban indicators

As with the case of the work on health care systems (section 2.3), the use of statistics to identify and describe urban areas has deep roots in academic research. Its origins go back to the Chicago School of Urban Sociology and research on human ecology and 'Social Area Analysis'. This kind of work has been widely reviewed before and excellent discussions appear in many standard urban geography texts (see Carter 1981, Clark 1982, Herbert and Thomas 1982, and more specifically, Herbert 1967, Rees 1971, and Johnson 1976).

The early pioneers of the so-called 'ecological approach' (ie the understanding of social development by analogy to biological processes in space) were McKenzie (1925), Burgess (1925) and Park (1936). They each sought to explain the complexities of the urban community by discovering regular patterns in its apparent confusion (Clark 1982), and hence describe the urban area (normally Chicago), using a variety of statistical indicators based on population structure and mobility, ethnic composition, housing characteristics and the environment. From these studies a variety of models appeared, dividing the city into a sequence of zones populated by those groups that were the most 'dominant'.

Shevky and Williams (1949) and Shevky and Bell (1955) introduced multivariate statistical techniques in order to analyse census data, which were used to form the basis of modern social area analysis (Brindley and Raine 1979). As Clark (1982) explains:

> "Social area analysis proceeds to identify sub-areas in the city by mapping a composite standardised index ranging from 0 to 100 for each construct. For example, the social rank index consists of an education and an occupational measure, and individual census tracts are assigned to a low middle or high position on a scale based on the values they show on these two variables. Tracts are next evaluated on the basis of an urbanisation index as measured by fertility, proportion of women in the labour force and the percentage of housing in family units. Finally, a segregation index is calculated by determining the distribution of the population in designated birthplace groups. This methodology has been applied in several studies of the social structure of cities throughout the world." (p 149)

The social area analyses of the 1940s and 1950s were followed by the factorial analyses of the 1960s and 1970s. The typical format of these studies was to examine the similarities and differences between wards or districts within a city using the Census of Population. Giggs (1970) provides one of the first, large-scale, UK census-based studies in his work on 'socially disorganised areas' in Barry, South Wales. He analysed a large number of census-based indicators, (listed in Figure 8) using principal components analysis, followed by the subsequent mapping of the various urban dimensions. As we saw in the national study of towns in Britain by Moser and Scott (1961) principal components analysis (which belongs to the wider field of factor analysis) uses input data to produce a correlation matrix which measures the relationship between all the possible pairs of variables. From the latent vectors of this correlation matrix components or factors are derived which group highly correlated variables from the input data. These are then open to scrutiny and interpretation. Davies (1970) explains this technique in more detail using data for Cardiff and Swansea. Amos (1970) provides a similar study of 'malaise' in Liverpool, again using a multivariate analysis to reduce a large number of inputs to more manageable dimensions of deprivation.

Since these early studies the census has continued to provide the backbone of intra-urban deprivation and quality of life studies.

Craig and Driver (1972) more formally assessed the suitability of population census data for use as social indicators, under the identification and quantification of adverse social need in small areas. One of the most comprehensive studies of the mid 1970s was that of Holterman (1975). She looked at the concentration of housing stress using 'Small Area Statistics' of the 1971 population census. 'Concentration ratios' were designed representing the number of persons or households in those worst EDs (enumeration districts) with a particular form of deprivation as a percentage of persons or households in all urban EDs (Carley 1981).

These kind of studies continue today. Davies (1984) provides one of the latest census-based indicator studies, using the 1981 population census in this case. He uses seven basic indicators of 'deprivation' standardised by a 'Z-score technique' into an eight-in composite indicator or 'index of deprivation'. From this the top and bottom six wards of London are ranked accordingly. (An analogy here with the earlier inter-urban US comparative studies). Similarly the recent work by Hirschfield and Rees (1984) and Hirschfield (1986) summarises the progress made over a number of years on the development of a social information system (for the small area), based on the Censuses of Population for 1971 and 1981 and especially concerned with studies of deprivation.

Apart from individual researchers many institutions have undertaken intra-urban quality of life or deprivation studies using census-type indicators. For example, the Department of the Environment (1975) identified 'Housing Action Areas' (HAAs) and 'Priority Neighbourhoods' by interpreting the following household indicators (quoted in Bracken 1981, p 284):

(i) proportion of households without exclusive use of bath or shower, inside wc, hot water tap.

(ii) proportion of households lacking one of the above amenities.

(iii) proportion of households sharing one of the above amenities.

(iv) proportion of households overcrowded.

(v) proportion of households in privately rented accommodation.

HAA's involved about 3 - 4% of the worst housing in Britain and gave the designating local authority the power to offer preferential house renovation grants and force improvements to be made, at the extreme by compulsory purchase (Carley 1981).

Perhaps the most impressive scheme of the 1970s was the neighbourhood classification idea of the Planning Research Application Group (PRAG) at the UK's Centre for Environmental Studies (see Webber 1977, 1978, 1979). Carley (1981) explains that forty indicators were derived from the Small Area Statistics of the census and a comprehensive cluster analysis was used to aggregate residential types on the basis of their similarity. From these neighbourhood type classifications different areas were examined by reference to a variety of social indicators (see also Carley 1981 p 134 -141).

Interest in community indicators also comes from the 'Community Indicators Programme' of the UK's Chartered Institute of Public Finance and Accountancy (CIPFA 1979). This followed a similar US scheme (the 'Social Economic Accounts System' developed by Fitzsimmons and Lavey, 1976), and was designed to publish social indicator data for UK communities and hence attempt to aid decision-making by local authorities. Carley (1981) again provides useful comment and in relation to the latter point reflects:

> the study of efficiency or the ratio of inputs to outputs, and the study of effectiveness, which is the extent to which goals or objectives are met by service provision. Thirdly, the information produced by the CIPFA system provides ammunition for local government in their negotiations with central government for various grants like the rate support grant (Kemp 1979)." (Carley 1981, p 52).

The issues raised here will be re-examined in later sections. (The range of indicators used by CIPFA are shown in Fig. 9).

Finally here, it is important to note that many local authorities or county councils have, at some time since 1970, produced their own internal reports on deprivation and social malaise, normally based on the various censuses and disaggregated to local levels: eg City of Manchester 1975, City of Newcastle-upon-Tyne 1974, Glasgow District Council 1983, Monmouthshire County Council 1974, Norfolk County Council 1976.

By the late 1960s and early 1970s, the impact of the social indicator movement was also beginning to have some effect on the type of studies undertaken in urban social geography. Once again the US provides many of the first examples of such intra-urban studies. David Smith for example, applied his ideas on territorial social indicators in case-studies of Tampa and Gainsville in Florida. (Smith and Gray 1972, Dickinson et al 1972). The type of indicators used in the Tampa study appear in Fig 10. Much of Smith's work was based on composite indicators, standardised for the purpose of amalgamation. In Dickinson et al (1972) they used a linear scale transformation (on a scale of 0 - 100) and the transformed scores were summed and divided by the number of variables to produce a final 'quality of life' indicator.

Parallelling the work of Smith were many local reports on US cities aimed also at measures of social well-being and quality of life. Martin Flax (1978) provides a thorough review of studies appearing between 1970 and 1977. Indeed by 1977 most towns and cities in the US had been investigated in relation to community and local variation of well being: typical are the studies of the Denver Urban Observatory (1973), The Urban Observatory of San Diego (1973), McKenzie (1973, for Albuquerque) and Ronti (1975, for Austin, Texas).

2.5 Indicators of performance

It seems fair to say that all the types of indicators introduced so far have, in some sense, been concerned with performance or assessment of performance. In the quote by Carley in the last section, we saw how the CIPFA study emphasised the importance of its role as measuring performance: the study of efficiency and effectiveness. Similarly all the other international, national and urban indicators could be said to measure the performance of these respective environments. Yet many of these indicators have been descriptive and static and not effectively connected to performance.

Boyce (1970) provides one of the first real attempts to define indicators within a 'larger definitional framework', one that includes 'standards, criteria and forecasts' (p 145). He goes on to define a performance characteristic as a statement consisting of:

> "(a) a definition which identifies some characteristic of a system as a function of its primitive qualities and attributes; and
> (b) a specification of the relationship of this characteristic to a desired, observed or forecast performance value". (p 148)

The performance characteristic can then be related to standards and criteria through the use of key indicators. Boyce expresses an indicator algebraically as

$$I = f(X_1^t \ldots X_n^t) \quad (t = 1,2 \ldots T)$$

where $f(X_1^t \ldots X_n^t)$ is the performance value of the characteristic or function for values $X_1 \ldots X_n$, observed at time t, past or present; $t = 1,2 \ldots T$ is then a time series on that indicator.

The development of such a framework, after Boyce, rarely seems to have occurred in real planning situations, although certain methods of plan evaluation (see section 3.2.4) come the closest (including Boyce, Day and McDonald 1970).

In a UK setting, it seems that it has been the Government who has shown the greatest interest in indicators of performance. This interest stretches back over many years, although it is only in recent times that much has happened. However, two early White Papers (Treasury : 1961, 1967) both suggested new strategies for nationalised industries. For example, Treasury (1967), called for indicators of performance which will provide regular and systematic information, thus making explicit the need for some review or monitoring process. The scale of the proposed exercise was large, calling for 'information about each industry's success in controlling its costs, increasing efficiency and economising in the use of manpower and capital resources'.

Such developments were slow to take off however, and it took another report by NEDO (1976) to stimulate further action. Today these kinds of performance indicators are beginning to appear on an annual basis in many Government departments/industries. Thus N.C.B. (1984) for example, have a section concerning performance indicators, reporting on variables such as coal face output per manshift, overall output per manshift, output per man per year, colliery costs per tonne etc (p 3). Similarly the National Bus Company (1983) reports on a variety of indicators such as working expenses per vehicle mile, average fare per passenger journey etc.

Another important avenue for governmental performance indicators especially in the USA yet echoed above by the reference to the National Bus Company, has been the field of public service delivery where both 'objective' indicators (efficiency and effectiveness for example) and 'subjective' indicators (ie perceived quality of service), (see also section 2.6 for discussion on these types of indicators), have been investigated in attempts to examine 'value for money' in local Government expenditure especially. One of the most substantial studies of performance indicators in monitoring the effectiveness of municipal services comes form the Urban Institute in Washington DC (Hatry et al 1977), who suggest the following criteria for selection of performance indicators (summarised by Carley):

"(1) Appropriateness and validity: indicators must be quantifiable, in line with goals and objectives for that service, and be oriented towards the meeting of citizen needs and minimising detrimental effects;

(2) Uniqueness, accuracy and reliability: indicators generally need not overlap, double counting should be avoided, but some redundancy may be useful for testing the measures themselves;

(3) Completeness and comprehensibility: any list of indicators should cover the desired objectives and be understandable;

(4) Controllability: the conditions measured must be at least partially under government control;

(5) Cost: staff and data collection costs must be reasonable;

(6) Feedback time: information should become available within the time-frame necessary for decision-making."
(Carley 1981 p 166)

Fig. 11 shows one set of such indicators for the measurement of recreation services (for example). See also Epping Forest District Council (1977), for a similar UK study.

Goldacre and Griffin (1983) note these general concerns about performance indicators in nationalised industries and local government services were parallelled by a concern to assess the performance of the National Health Service, (NHS), especially following the Committee of Public Accounts in 1981, which stressed the need to monitor key indicators of performance in the NHS. In January 1982 the Secretary of State for Social Services announced arrangements for departmental reviews of each Regional Health Authority, and the first list of indicators were published later in 1982 (see Goldacre and Griffin 1983, DHSS 1984). The first package of performance indicators came under the major headings of clinical activity, finance, manpower, support service and estate management. Fig. 12 lists a set of indicators concerned with clinical activity.

The review of health service indicators by Goldacre and Griffin (1983) also provides an excellent account of the importance of a performance indicator framework. They quote the Secretary of State

for Social Services, from 'Hansard':

> "Indicators will enable comparisons to be made between districts and so help ministers and regional chairmen at their annual review meeting to assess the performance of constituent health authorities in using manpower and other resources efficiently." (p 3)

and similarly Yates (1982) makes an important point:

> "'One should not expect indicators about performance in the NHS to be absolutely precise or accurate', but that, although the use of indicators does not guarantee the identification of poor or good performance, they can be used to 'tell you something about the probabilities of where some elements of poor performance might be found'." (Quoted in Goldacre and Griffin p 79)

However, not all commentators agree that a performance indicator framework for the NHS is the best strategy for futher progress. The reviews of Klein (1982) and Pollitt (1985) provide many reservations and lead us on to looking far more generally at the pros and cons of a performance indicator or urban indicator framework.

2.6 Cornucopia or Pandora's box?

Having discussed the ideas associated with social, urban and 'performance' indicators, it is now necessary to address a number of important issues which emerge, beginning with the question of how we determine which are the most important indicators to study. This issue is not new: the Guillebaud Committee of the NHS in 1956 recognised the problem of finding the right statistics to measure efficiency (Guillebaud 1956). Similarly Knox (1978a) notes the difficulty of selecting indicators from the wide variety possible, for example when using the Census of Population. He refers to the almost 'infinite number' which can be derived from the small area statistics. This leads him to speculate:

> "Notwithstanding the utility of carefully formulated source list of variables, however, there remains the problem of selecting the most appropriate. With such a large number to choose from, the biggest danger is that of neglecting the more complex and apparently esoteric formulations in favour of conventional or more accessible (the two are often synonymous) variables which may not be as sensitive." (p 77)

Gehrmann (1978) for example, examined the way in which a widely different ranking of cities was possible simply through the choice of one particular social indicator system over another.

A related issue is that by concentrating on certain key indicators one might obscure equally pressing social problems (Henriot 1970). This might come about through sheer ignorance, lack of suitable information or data, or indeed, as some authors point out, through a deliberate policy to use social indicators as 'vindicators'. A quote from Brand (1975) is particularly apt here:

> "The procedure is simple and well-known. When you are threatened by some unpleasant development, do a statistical appraisal of the situation. Unless you are extremely unlucky you will be able to get some figures which will justify you in doing what you were going to do anyway - often nothing. Even better, get someone in a university or research agency to do the study for you. You have a fair chance of knowing what he is going to say anyway so you can hand pick your chap and when he finally presents his report (usually two years late anyway, which is all to the good) it vindicates you." (p 86)

The problem of 'vindication' is more real when indicators are ideologically loaded (Grichting 1984).

Having found the problem of which indicators to use, we then face the task of judging whether a particular indicator is suggesting a 'good' or 'bad' performance or state. This leads on to issues of accepting standards, norms or objectives. Goldacre and Griffin (1983 p 11) explore this problem in relation to health care indicators and reflect that many authors point out that without objectives, standards, or at least a statement of expectations, there can be no appraisal of performance.

It is possible for certain sub-systems to measure the output from individuals against explicit policy aims or expectations. Knox (1975) explains that 'absolute' indicators can be used where there is significant or substantial 'scientific' agreement over maximum or minimum levels necessary for certain aspects of well-being. His examples include minimum requirements of clean air and minimum levels of protein or intake (Knox 1975 p 12). Often these 'scientific agreements' are contained within strategy plans. The Grey Book (DHSS 1972) for example, in relation to health care planning, emphasised that it is essential that performance is monitored in relation to health authority plans: that is, the plan will provide the 'yardstick against which to measure performance'. Hence decisions about norms or standards are left to those at the top level of policy management. (It is also interesting to note that in many planned economies these kinds of norms are indeed set for urban planning strategies:- ie set floorspace per 1000 inhabitants, ratios for various urban facilities etc: see Moucka 1983).

However, more often than not, we can get round this problem by focussing on relative standards, which might themselves then be open to further analysis or discussion. These would normally relate to more general goals, or ideals concerning a fairer or more equitable society (terms which needed more elaboration and will be returned to shortly). These sentiments are echoed by the progress report on the joint exercise between the DHSS and the Northern Region (DHSS 1982):

> "It is recognised from the outset that no simple indicator or combination of indicators could lead to a firm conclusion on whether the use of existing resources was 'efficient', or 'inefficient', 'good'or 'bad'. Such a judgement could only be reached after further detailed study of local circumstances." (Quoted in Goldacre and Griffin (1983) p 77)

The issues of norms and standards, and the possible solution of concentrating on relative values, still raises questions concerning a more fundamental debate on whether the norms selected should reflect measures of efficiency or equity. That is, whilst it may be possible and useful to measure the performance of a system in terms of the efficiency of resource allocation and management, it may be more socially beneficial to explore what this means for the consumer in terms

of his/her access and overall ability to consume against the price and availability of that consumption. Clearly both sides of the coin are important. In terms of efficiency Smith notes succinctly:

> "We are all sensitive about the spending of our tax dollars, yet seldom do we ask for a cost-benefit accounting of this. (1973, p 57)

and

> "The capacity to evaluate alternative locations accurately with respect to efficiency criteria is extremely useful. In the private sector it helps businessmen to make money or avoid a loss, which benefits those whose employment depends on the firm's viability and also customers whose satisfaction is determined to some extent by the price they have to pay for the goods. In the public sector or in a system where the means of production are owned by the people, comparative cost-analyses can help to ensure that society gets the most out of its investment or that the production required is achieved at least expense of public funds." (Smith 1977, p 303 - 4)

However, concentrating purely on efficiency issues masks other important equity issues. The concern for equity in society is a theme echoed and widely discussed in all aspects of social science. In economics, 'welfare economics', is now a well-founded subdiscipline especially concerning issues of distribution and resource allocation. Indeed Chisholm (1971) suggested welfare economics as a possible alternative to microeconomics as a point of departure for location theory. Bracken (1981) notes that proponents of the welfare view argue that some kind of welfare income measure is vital to a proper evaluation of the re-distributional effects of urban policies (see Walker 1980, Rawls 1973, Rowley and Peacock 1975). Similarly Ben-Shahar et al (1969) simply argue:

> "The goal of the town planner is to make a plan that maximises the value of a social welfare function subject to a number of constraints." (p 105)

Similarly there is now a large literature on equity and the distribution of facilities in fields such as sociology and social policy. Lineberry (1977) is perhaps one of the best introductions.

Geographers too have been equally concerned with issues of equity, welfare and more recently social justice. David Harvey (1973) provided much stimulus for a range of other texts during the 1970s as did the work on territorial social indicators by David Smith mentioned earlier: ie (Knox 1975, Coates et al 1977, Smith 1977, 1979). Smith's philosophy built on Lasswell's (1958) definition of political science as the study of 'who gets what, when and how' and Samuelson's (1973) idea of economics as concerned with 'what, how and for whom', to add the important spatial dimension. Thus he defined human geography as the study of 'who gets what, where and how'. (Smith 1974, 1977).

The solution to the 'efficiency v equity' issue will nearly always have to be some compromise. Both Harvey and Smith have stressed that it is not possible to ignore efficiency issues totally when in search for social justice:

> ". . . I want to diverge from the usual mode of normative analysis and look at the possibility of constructing a normative theory of spatial or territorial allocation based on principles of social justice. I do not propose this as an alternative framework to that of efficiency. In the long run it will be most beneficial if efficiency and distribution are explored jointly. . . . It is counter-productive in the long run to devise a socially just distribution if the size of the product to be distributed shrinks markedly through the inefficient use of scarce resources. In the long-long-run, therefore, social justice and efficiency are very much the same thing." (Harvey 1973 p 96 - 97)

> "How quality of life is defined is, of course, subject to many further value judgements. . . . . It is sufficient here to say that it concerns efficiency in the use of resources and equity or fairness in distribution of the benefits and penalties of life." (Smith 1977 p xi)

However, as with most areas of social science, we should note that not all agree efficiency and equity can be considered together. Culyer (1977) for example argues that the categories of justice and efficiency should be kept 'entirely seperate' in case of 'logical inconsistency' and 'professional arrogance'.

For more discussion on the debate between equity and efficiency especially in relation to the location of facilities, see Morrill (1974) McAllister (1976), McGrew and Monroe (1975) and Smith (1977).

How can we compromise between efficiency and equity issues, in any meaningful way, when examining indicators? Wilson (1984a) offers one solution which if integrated within a wider planning framework (see sections 3 and 4) offers much potential:

> ". . . We gain an interesting new perspective on the equity-efficiency problem by calculating residence-based and facility-based indicators. For residents, the focus is on a vector of indicators which, though difficult to weight relative to each other, offer a picture of the quality of life. In policy terms, there will be an interest in some kind of equitable distribution of these vectors across space (and across population classes). For facilities, the focus is on efficiency." (p 13)

Concern with equity issues has also led many researchers to criticise aggregate 'hard data' indicators (called 'objective' indicators, though as we have seen, these too are often value-laden) and look instead towards indicators which reflect personal attitudes, beliefs and feelings:- so called 'subjective' indicators. The size of interest in subjective indicators reflects a belief that the use of 'objective' measures alone is highly suspect, and researchers must go beyond 'objective' outputs and measure the 'reality' in which people live. (See Schneider 1974, Kuz 1978, Kennedy et al 1978, Angrist et al 1976).

There are a number of variations within the subjective indicator literature. Andrews (1981) identifies three levels of such indicators: 'general or global level', reflecting general happiness with life,

'particular life concerns', reflecting one's standard of living and evaluation of one's housing, family, neighbourhood etc, and 'subconcerns' reflecting one's very local surroundings, even down to the scale of satisfaction with one's own kitchen! Hayden (1977) adds another important dimension: that subjective indicators should measure whether social arrangements, programmes and resource allocations are consistent with cultural values. Knox (1976) provides a table containing typical 'domains' covered by social indicators (Fig.1

Whilst accepting that subjective indicators can provide useful signposts to social problems we must be aware of the fact that perceived levels of performance or service do not necessarily reflect actual levels. Carley (1981) gives three important reasons why this might be the case:

(1) "It is not feasible for clients to be dissatisfied with a service because of a variety of unmet needs which that service is not designed to fulfil."

(2) Lack of real knowledge might effect expressed feelings: "For example, the majority of citizens might be quite satisfied with environmental health services which are in fact substandard and inefficient."

(3) Feelings may be purely influenced by attitudes to government and politics: "For example, a conservative person may express that the level of police service is inadequate based on general feelings about 'law and order' rather than his own experience of police or crime. A general rule about such misleading results is that they are possible whenever there are determinants of the subjective indicator other than the service under consideration." (Stipak 1979)

(Carley 1981, p 169 - 170)

However, despite these problems, subjective indicators may from time to time provide useful insights into real problems that should not be ignored. Again as Carley (1981) points out:

"If people perceive the streets as unsafe, or public transport as poor, then that is an issue even if the level of crime is low or the buses are frequent." (p 170)

Finally, in relation to possible areas of concern with an indicator-based approach, it is important to be aware of the concern of some authors over the so-called 'fetishism of space': that is the belief that by concentrating on certain areas, or by identifying certain areas for aid or investment, one might miss other areas equally in need. Certain areas then, may score relatively low on one aspect of welfare but not on other aspect, (as O'Loughlin 1983, points out, areas of 'multiple deprivation' may be less extensive than previously thought) whilst conversely some areas of 'well-being' may contain pockets of deprivation which do not emerge from area-based studies. (This is often termed the 'ecological fallacy', of attributing average conditions to the entire population of the area under study).

MacLaren (1981), for example, in a study of Dundee, found that deprived households were scattered throughout the city whilst Glennester and Hatch (1974) and Berthoud (1976) criticised area-based studies for neglecting large numbers of the deprived who do not happen to live in deprived neighbourhoods. Stegman (1979) too, found that a microlevel study at the 'block level' reveals significant variation within target areas, so that not all blocks should receive an infusion of scarce resources.

Some authors would go even further by arguing that deprived neighbourhoods are only surface manifestations of the 'withdrawal of capital and of unequal resource allocation' (O'Loughlin 1983). 'Radical' geographers for example, hold that social structures themselves must be altered before meaningful change can be accomplished. Duncan (1974) for example, argued that area-based studies are merely 'cosmetic', 'papering over the cracks' without touching the underlying causes of deprivation (see also Knox (1982) for a general discussion and Hamnett 1979 and Lee 1976).

The response to this argument is fairly well-known. Given that it is unlikely such political or social reform is possible in the short run, solutions to current deprivation problems still have to be pursued and resources still have to be allocated and assessed.

As Wilson (1984b) stresses, 'to deny this, as some critics have, is a nonsense'. Similarly Knox (1985, p 413) makes a simple point:

> "Space may not be a major or independent social force but spatial outcomes are still of considerable economic, social and political significance."

None of these problems can, or should, of course, be glossed over. Indeed for those contemplating the use of an (area-based) indicator approach it is vital to be aware of the dangers and potential pitfalls. However, we have offered some responses whilst progressing through this section of the review because we remain optimistic that there is much useful ground still to cover. Carley (1981) reminds us that this is still a relatively young field and any further developments should be encouraged. We take up this challenge by developing a framework for indicators in urban planning and a new set of performance indicators for that purpose.

3 Indicators and model-based urban planning: a preliminary review

3.1 Introduction

In this section we attempt a more detailed review of how indicators or an indicator-based approach may fit into a possible urban planning framework. In section 3.2 is the framework itself, after Nijkamp's (1983) categories of description, impact analysis and evaluation. In section 3.3 we review the use of a model-based indicator framework based on accessibility and consumers' surplus measures. This all serves as a preliminary to an attack in section 4 on performance indicators in the context of contemporary urban modelling.

In section 2 we saw some of the advantages of the social, urban indicator framework at various levels of resolution, and it is worth reminding ourselves of the potential of an indicator-based approach

at the intra-urban planning level. Bracken (1981) provides a general statement on the potential of such an approach for planners:

> "In making use of indicators, urban planners can draw upon the considerable experience of a wide range of social sciences, and it is widely argued that the development of meaningful and informative indicators is central to the development of a policy analytic capability on the part of planners." (p 281)

Bracken also suggests that a set of indicators which measure performance under different policies relating to spatial structure may be used in both a positive (what will happen if . . .) and a normative (what ought to happen) manner. Hence he suggests, indicators can provide tangible measures of performance by which alternatives can be compared, and thus rejected or accepted, and can provide measures by which any improvement achieved in a later stage of the cyclical process can be evaluated relative to earlier attempts (p 81), (and see Mackett 1975).

Friedman and Marlin (1976) provide a similarly useful summary of the importance of rating the performance of individual cities. They are primarily concerned with inter-urban perspectives yet note, in terms of intra-urban studies:

> "By adopting measures of performance to geographic areas within individual cities, ratings are now able to evaluate the delivery of services to different neighbourhoods. The challenge of equity in the distribution of programs within the city, recently buttressed by judicial action, is increasingly an issue of far-reaching importance in the operations of urban government. By breaking down these city-wide measures there is a readily available tool to assess discrepancies from one area to another." (p 19)

3.2 A framework for urban planning

3.2.1 Introduction

The literature on planning and the planning process is again extensive and hence there are a number of working definitions available. Here we adopt a fairly simple three-stage framework as presented by Nijkamp (1983,1984): description, impact analysis

(in which we include the process of monitoring) and evaluation. However, we should note that many other authors have produced similar such frameworks. Boyce, Day and McDonald (1970) also examine a similar three-stage process of initial inventory and analysis, plan making and evaluation, although each of these major categories are highly disaggregated. Carlisle (1972), specifically in relation to indicators, identifies a not too dissimilar four-stage process; information, prediction, a problem-orientated stage and programme evaluation.

Having made these distinctions between the processes in this planning framework it is still important to be aware of the fact that planning is very much a cyclical process and it may often be difficult to maintain such a neat pigeon-holing. Certainly Boyce Day and McDonald (1970) continually stress the need to maintain the cyclical nature of planning in which some of the stages will be repeated and monitored and gradually refined. However, let us examine Nijkamp's framework in more detail.

3.2.2 Description

Nijkamp (1983, 1984) categorizes this stage of the process as the structural representation of data regarding a system, and includes the development of social and urban indicators within this category.

Of crucial importance in Nijkamp's analysis is the definition of a set of sub-systems or 'profiles', to use his terminology, including the major components of the urban environment. For each of these, indicators could then be built-up describing the current state of particular areas within the city. Nijkamp's list of sub-systems is fairly typical and includes all the major urban components: housing, infrastructure, finances, facilities, environment and energy (see Nijkamp, 1983, p 162 for example, and a similar set of sub-systems in Wilson, 1984a, p 20). To this list we might add particularly the major services like health and education. Carlisle (1972)and Bracken (1981) both note the

importance, at this stage of the cycle, to ask questions on socially relevant issues concerning these different sub-systems and, interestingly, the urban whole. This introduces the possibility of maintaining a more comprehensive framework as well as exploring the various sub-systems.

Clearly this stage of the cycle is crucially important since the remaining sections rely on the ability of the descriptive stage to represent accurately the current situation (whatever time period that may be) in an adequate and concise manner.

3.2.3 Impact Analysis

Nijkamp's (1983) second stage of the planning process is impact analysis:

> "The main aim of impact analyses was to get more complete, systematic and comprehensive information on the effects of public policy decisions or of exogenous shifts in the parameters or data 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 element of the profiles characterising a system." (p 262)

Typically therefore, this is the area most likely to have experienced the use of some systematic appraisal method or modelling framework. (See Wilson 1974a, 1981, Batty 1976, 1978, Perraton and Baxter 1974, Batey and Breheney 1978).

Of more immediate interest and concern here is the possible relationship between urban models and an indicator framework. Clearly, having defined a set of indicators as part of the descriptive process, the interest may lie in the assessment of those indicators under various policy options or model parameter variations. (This will be explored in more detail in sections 3.3 and 4.)

Concern with impact analysis should not be purely static and

hence there is a continuous need to monitor the system of interest over time. Most authors would agree that since planning is a continuous process then we need a system which incorporates a continuous feedback of information and data on change and the impacts of that change. Brown (1984) makes an important distinction between monitoring and what he refers to as 'a review':- monitoring assumed to be more concerned with the continuous assembly of information and re-assessment of aspects of planning policies, whereas the review process is more concerned with periodic, yet comprehensive, re-evaluations. (Brown 1984). Clearly monitoring would seem to be the most desirable policy to pursue but this may depend on the availability of data which, typically, is far from continuously supplied.

Again the use of an indicator approach may be beneficial in terms of monitoring, (or reviewing):

> "The assessment of benefit over time comes through monitoring: the essential design requirement is that each policy intention should have associated with it a clearly defined indicator, or set of indicators, which are capable of revealing discrete information about the performance of that policy". (Bracken 1981, p 86)

In terms of monitoring however, Floyd (1978) offers some reservations. He suggests that attempts to implement such an approach have floundered on the difficulties encountered in identifying such key indicators and in determining their threshold values (issues which were examined in section 2.6). Clearly to overcome Floyd's reservations careful thought will be needed on both data sources (and indeed time series data) and a reliable information system in which to operate (see Birkin and Clarke 1985).

3.2.4 Evaluation: cost-benefit analysis and related techniques

In many respects, the process of evaluation is an obvious extension of the ideas discussed above in terms of description

and impact analysis (including monitoring). That is, given a variety of procedures or planning strategies (against a given backcloth) and their respective impacts, which is ultimately to be chosen? There are a vast range of techniques to determine this choice, a number of which will be outlined below. For a more comprehensive review see Lichfield et al (1975), Fitz-Gibbon and Morris (1979), Rossi et al (1979), Lichfield (1970), Perraton (1974) and Wilson (1974a ch 13).

Nijkamp (1983) refers to the process of evaluation thus:

> "Evaluation refers to the process of analysing plans, proposals or projects with a view to searching out their comparative advantages and the act of setting down the findings of such analyses in a logical framework. Thus, the essence of evaluation in a planning context is the assessment of the comparative merits of different courses of action, so as to assist the process of decision-making". (p 63)

From this extensive field of interest, a number of techniques and procedures emerge. Each uses a variety of information variables to measure the extent to which a certain policy meets desired aims (usually through obtaining the 'highest score' in some weighted ranking procedure). Some of these variables are single measures of a particular phenomenon whilst others are more sophisticated indicator-type variables which normally involve the manipulation of the original data sources.

The earliest and perhaps most often used technique is cost-benefit analysis (see Mishan, 1972, for example). The aim is obviously to weigh the forecasted costs of undertaking a certain project against the expected benefits. Economic cost-benefit analysis tends to be primarily concerned with efficiency or variables based on income and finance, as opposed to social cost-benefit analysis which focuses attention on the well-being of members of society rather than decision-takers. Lichfield (1966) introduces the 'planning balance sheet analysis' (PBSA) which crudely speaking, is a mixture of the two cost-benefit approaches. The aim of PBSA is to look at the effects of a wide variety of groups including members of the community and decision-takers. (Section 3.3.4 offers a more thorough exposition on cost-benefit

indicators.)

A second well-known technique is the 'goal achievement matrix' after Morris Hill (1968, 1973). Hill developed this procedure because of the limitations he felt were apparent in cost-benefit analysis and PBSA (or development balance sheet). His main objection to these approaches was the lack of stated objectives. Hill (1968) remarks

> "Thus a major criticism of the 'development balance sheet' is that it does not appear to recognize that benefits and costs have only instrumental value. Benefits and costs have meaning only in relation to a well-defined objective. ... It is meaningful to add or compare benefits and costs only if they refer to a common objective". (p 21)

As regards his goal-achievement matrix Hill comments:

> "For the purposes of the goals-achievement matrix, goals should, as far as possible, be defined operationally, that is, they should be expressed as objectives. In this way the degree of achievement of the various objectives can be measured directly from the costs and benefits that have been identified". (p 22)

Invariably, the information variables are 'weighted' in some preferred way and then summed so that the desired plan or policy is that which has the largest associated overall index or summation value.

Wilson (1974a, p 359) adapts Hill's goals achievement matrix as follows: identify goals or goal indicators by the index $g = 1, 2, 3 \ldots$, and associated weight α_g. Groups of the population are identified by $\beta = 1, 2, 3$ and associated weights β^n. Costs and benefits can then be computed as C_g^n, B_g^n respectively, for $n = 1, 2, 3$. This gives the following table:

Table 1 Hill's goals achievement matrix

	Goal indicator	g = 1		2	...
	Goal weight		α_1	α_2	...
Group n =	Group weight	cost	benefit	cost	benefit
1	β^1	C_1^1	B_1^1	C_2^1	B_2^1
2	β^2	C_1^2	B_1^2	C_2^2	B_2^2
.	.	.	.	.	.
.	.	.	.	.	.

Source (Wilson 1974a, p 359)

By adding the superscript m to indicate the m plan, Wilson states the aggregate value-indicator for plan m as,

$$W^m = \sum_g \sum_n \alpha_g \beta^n (B_g^{nm} - C_g^{nm}) \qquad (1)$$

Thus the plan with the highest W^m can be chosen.

This technique has been applied in a number of planning contexts. The most cited example is that of the Coventry-Solihull- Warwickshire Regional study (1971). Eight full-time planners worked for three years to examine the future development of major residential areas, major shopping and employment centres, transport network proposals and areas for rural conservation. After applying a sensitivity analysis to a set of proposals, four basic strategies concerning future growth, were considered. The whole area was sub-divided into 5 km square zones, and the attractiveness of each zone was assessed by measuring its potential performance in relation to a number of planning objectives.

The stated goals included, the greatest degree of balance and prosperity, the best living and working environment, the greatest choice of opportunities and the greatest degree of flexibility in relation to ability to adapt to change. Then,

the extent of achievement of an objective was assessed using a performance criterion or index. Thus if an objective (within the set of goals mentioned above) was to locate new development so that the loss of workable mineral resources was kept to a minimum, one performance index was the area of each mineral deposit lost to new developments, within each strategy, as a percentage of the total area of the mineral deposit within the region as a whole.

An urban example of Hill's goal-achievement matrix approach, was that of Brighton in the early 1970's (Brighton Urban Structure Plan, 1971). The planning authorities were concerned with the preparation of an urban structure plan for the Sussex coastal area between Lancing and Seaford. Four selected strategies were set up and fifteen discriminatory objectives chosen. In order to measure the effectiveness of the four selected strategies certain criteria were established for the fifteen objectives and a set of fifty tests were used to measure the degree to which each strategy met these criteria. The scores achieved for each objective were aggregated and then weighted separately according to valuations derived from a survey of public opinion about the relative importance of the different objectives.

A few studies have incorporated a more formal use of indicators in their evaluation strategy. Echenique, Crowther and Lindsay (1972), for example, were concerned with evaluating the effects of a new towns programme in south-west England. They chose a set of indicators 'which describe various physical characteristics of spatial structure', to compare investment in four possible towns. The list of indicators used incorporates those which represent costs borne by development agencies, local authorities and indirectly by tax payers (producers); those which represent costs and benefits to residents, employers and employees; those which represent services and those involved in travel and communications. The fourteen indicators are listed at Appendix 1.

All of the developments described above which have their roots in cost-benefit analysis represent a 'softening' of the CBA framework: attempts are made to avoid the conceptual and

measurement problems associated with a full-blown 'economic' CBA framework, while still maintaining a connection. A performance indicators' framework represents a further broadening: an attempt to employ any indicator which is useful. There is a danger then of developing a rag-bag of indicators and we will have to seek to avoid this.

More recent attention in the literature on evaluation techniques has focused on the use of 'multicriteria analysis' (see the work of Nijkamp, 1979; Nijkamp and van Delft, 1977, Nijkamp and Spronk, 1981, Hinloopen and Nijkamp, 1984, Voogd, 1983). Nijkamp and van Delft (1977) explain that multicriteria analysis has emerged because of the limitations of the monetary evaluation methods and because of the rise in the number of conflicting interest groups involved in each planning inquiry. In relation to the first issue, they explain:

> "The major advantage of a multicriteria analysis is its capacity to take account of a whole gamut of differing, yet relevant criteria, even if these criteria cannot be related to monetary outcomes". (p 19)

In relation to the second issue Nijkamp (1979) stresses the need to be aware of the multiplicity of different objectives:

> "The need for adjusted methods is even more apparent due to the mutually conflicting or noncommensurable nature of many objectives". (p 129)

Whilst the 'tools' now used may be more sophisticated (including concordance analysis, permutation analysis, regime analysis, discordance analysis) the overall procedures are not too dissimilar from more traditional techniques. That is a variety of overall objectives are stated (from various interest groups) and criteria or indicators are devised and weighted according to the different interest groups. 'Criteria scores' are then calculated for these weighting procedures and the strategy or plan which emerges as 'best' most often (in terms of goal achievement) is then chosen. The difference between these methods and that of Hill above, turns on the kind of data which can be analysed and hence the more sophisticated procedures

for doing so, (especially in relation to 'soft' qualitative data).

Nijkamp and van Delft (1977), for example, investigated the problem of how to select an 'optimal' bundle of industrial activities for a new industrial area in Holland (the Maasvlakte region). Six different goals were identified as being important and five alternative plans investigated. To evaluate goal achievement, eight variables of criteria were examined ranging from environmental concerns such as pollution emissions to cost criteria such as nearby port charges. They used a range of weighting schemes according to the interest group involved. (Different actors were allowed to influence the weighting process, making the procedure more like a general sensitivity analysis). Again the plan which scored most highly, over all the different schemes of weighting, was the suggested policy option. Voogd (1983) also gives many examples of evaluating different planning strategies using 'priority ranking' for both economic and social considerations. These two considerations are then synthesised. One of Voogd's examples is the strategy to improve housing provision in south east Ijsselmonds Holland, in order to relax pressure on the housing markets of Rotterdam and Dordrecht. The purpose of the evaluation is to classify potential sites: he thus examines five main criteria; the condition of the soil in relation to building activities; the quality of the surrounding environment; the availability of local facilities; the state of agricultural activities in the area (in terms of possible displacement); and accessibility. These criteria are evaluated for each potential site in terms of economic advantages and social advantages. The two are fused together, as mentioned above, for a final decision on which site to choose.

3.3 Some concepts associated with early model-based approaches

3.3.1 Introduction

Urban modellers and associated planners have not traditionally paid much attention to performance indicators as such, though we noted some exceptions above. On the whole, they

have focused on the direct use of model predictions in planning: population and job distributions, for example, and flows on transport networks. There are two notable exceptions to this which we explore below. The first is concerned with the concept of 'accessibility' (section 3.3.3) and the second with the measurement of consumers' surplus as a benefit indicator, mainly in transport studies, but also in relation to service provision (section 3.3.4). We begin, however, with a preliminary exploration of the work of authors who have attempted to build social indicator models directly.

3.3.2 Social indicator models

We saw in section 2.2 how Land (1971) had emphasised the importance of defining an indicator within a broader framework, as part of a 'conceptual system of social processes'. However, Gross (1966) was one of the first in the field to suggest social and economic variables should be incorporated into social-indicator models in order to explore the structure and performance of social systems. The 1970's saw many attempts to use an indicator-based framework in the construction of social models. Early exponents of such attempts were John Sullivan (ie. 1971, 1974), James Anderson (1972, 1973) and Kenneth Land. Land (1971) for example, provided a critique of purely descriptive reporting of indicators, and argued instead for their incorporation within the 'conceptual system' mentioned above. (For excellent reviews see Fox, 1974, Land and Spilerman(eds.) 1975, Warren et al 1980, Carley, 1981 and Juster and Land (eds.) 1981.)

From these texts it is apparent that there is a wide variety of social modelling approaches. A couple of examples illustrates this variation. One important researcher has been Ben-Chieh Liu working with 'quality of life production model': for individual i, at time t, quality of life is measured as a function of physical (PH) and psychological inputs (PS). That is:

$$QOL_{it} = f(PH_{it}, PS_{it}) \qquad (2)$$

Disaggregating further, the model form becomes

$$QOL_{it} = F(EC_{it}, PW_{it}, EN_{it}, HE_{it}, SO_{it} \; PS_{it})$$

with the following definition:

SO - social inputs
EC - economic inputs
PW - political and welfare inputs
EN - environmental inputs
HE - health and education inputs

These are discussed in more detail in Ben-Chieh Liu (1978). Unfortunately the psychological inputs are held constant because these are not 'normally quantifiable at the present'. (1978, p 249). This is the inevitable operational breakdown when trying to incorporate subjective indicators into a modelling framework.

Land's framework has been based on 'sociometric' social models, introducing time series statistics aimed at dynamic quantitative modelling. The theme of this work is based on transition models, from the demographic work of Stone (1971, 1975). (Inflow-outflow/input-output demographic accounting equations.) The work is too detailed to be adequately described here but an excellent review appears in Land and MacMillan (1981).

There is clearly much more ground to cover in social indicator model research and Carley (1981) explains some of the difficulties associated with such modelling. However, he does reflect that 'this type of approach is the only one which will allow for the continued development and refinement of social indicators in aid of social theory' (p 85). Clearly this field will provide much interest in the future.

However the main theme of this section is models in geography and planning and how these might identify and monitor a variety of social and spatial problems. To tackle this we examine two of the most common types of model-based indicator study, beginning with accessibility and following this with consumer surplus-based benefit measures.

3.3.3 Accessibility indicators

Geographers have long been interested in accessibility, as a fundamental component of the discipline and to some extent as an indicator. Smith (1977) describes accessibility as basic to location planning whilst Pred (1977) and Knox (1978a) both note the importance of measuring 'quality of life' in relation to accessibility to key services and facilities. Similarly Koening (1980) concludes his paper:

> "Accessibility appears more and more as a key concept in urban and transport planning. It expresses what is possibly the major function of cities: ie. providing opportunities for easy interaction or exchange". (p 169)

Because of its importance in geographical studies a number of authors have expressed surprise that few have addressed the 'crucial question of territorial variations' in terms of accessibility to opportunities and urban resources. (Knox 1978a, p 369). However, there have been some studies aimed at examining accessibility through the variables incorporated within or output from urban models. The most common practice has been to relate the concept to the basic gravity model or the broader family of spatial interaction models (Wilson, 1971). Knox (1978a) explains why:

> "Gravity models, which are frequently used in geography and urban and regional planning to explain or predict spatial interaction of various kinds, are specifically designed to handle distance-decay effects, and can be easily modified to provide measures of accessibility which reflect more realistically the relative level of spatial opportunity inherent in any one part of an urban or regional system". (p 373)

Hansen (1959) provided one of the simplest measures of accessibility in a gravity-like formula.

$$A_i = \sum_j E_j \, e^{-\beta c_{ij}} \qquad (4)$$

Where A_i is accessibility in zone i to employment (E_j)

facilities in zone j, and c_{ij} is the cost of travelling from i to j. (β is a parameter to be determined). This embodies the crucial idea that accessibility is related both to distance (or cost) and the scale of the opportunities at the distant locations. Schneider and Symons (1971) provide an early example of the direct use of the gravity model. They define an index of access opportunity (AO) as

$$AO_i = \sum_j \frac{S_j}{t^b_{ij}} \qquad (5)$$

where S is the size of some facility j
t is the time taken to travel from i to j
b is the distance-decay exponent.

This standard measure can then be weighted according to other criteria, such as the rate of car ownership. Knox (1978a) incorporates parameters based on travel speeds by car and by transit (public transport), to transform the AO_i measure above to

$$TA_i = C_i\left(\frac{A_i}{S_a}\right) + (100 - C_i)\left(\frac{A_i}{S_t}\right) \qquad (6)$$

where TA_i is the new index of accessibility for zone i, C_i the percentage of car-owning households in zone i, and Sa and St are the average times taken to travel a given distance by car and transit respectively:

> "The index then provides a reasonably sensitive yet robust indicator of the accessibility of different localities to a given spatial distribution of facilities". (Knox, 1978a, p 373)

There have been a number of modified versions of the above Hansen-type framework. Ingram (1971) for example, looks at the 'Gaussian measure', to define

$$A_i = \sum_j S_j \exp\left(\frac{-d_{ij}^2}{v}\right) \qquad (7)$$

where the variables are as above with v defined as a constant. But this, in effect, involves a specific choice of decay function and specific parameter value, both of which are

difficult to justify.

Oberg (1976) develops the 'cumulative opportunities' measure:

$$A_i = O_i(D) \left[D - \left(\sum_j d_{ij}/O_i(D)\right)\right] \qquad (8)$$

where $O_i(D)$ is the total number of opportunities available to household i within distance D from home. D is taken as a measure of maximum walking distance.

A retailing example is given by Guy (1977 and 1983) where,

$$A_i = \sum_K d_{ij}^{min}(K) \; E_K / \sum_K E_K \qquad (9)$$

where d_{ij}^{min} is the minimum straight-line distance to a shop j in which good K is available and E_K is the mean expenditure per household on good K. In this case, there is no attempt to build into the index the kind of behaviour represented in a spatial interaction model.

As Smith (1977) explains, once a satisfactory index of accessibility has been developed it can be used as a goal attainment indicator. Building on the Schneider and Symons (1971) example above, Smith develops an indicator of the 'efficiency of the present location of facilities, measured by accessibility to a given spatial pattern of potential customers'. By multiplying each place's AO index by its population (N), summing for all i and dividing by total population, Smith arrives at the following index,

$$A = \frac{\Sigma(AO_i \times N_i)}{\Sigma N_i} \qquad (10)$$

(Smith 1977, p 182)

It would be possible, of course, to replace AO_i by any other relevant measure within this formula.

Using the gravity or interaction model in this way throws up the issue of 'efficiency v equity' again. Schneider and

Symons (1971) did address this directly, and Smith (1977) suggests that the mean value of A0 might be interpreted as an efficiency indicator (the higher the better) whilst the standard deviation could be a measure of equity (the lower the better, as this measures variation in accessibility amongst residential locations). In many instances efficiency will demand large E_j's (for example) in the Hansen formula (4), and this will be in conflict with an equitable 'flat' spatial distribution of the accessibility indicator; so the equity-efficiency problem is exposed quite sharply. The 'equity v efficiency' issue will re-emerge in relation to benefit indicators below.

More generally in terms of the family of spatial interaction models (Wilson 1971) it is possible to interpret the balancing factors, in the entropy-maximisation derivation, as descriptive measures of accessibility (Wilson 1967, 1974a). In the case of singly-constrained models, the balancing factors are the inverse of the Hansen accessibility, and they can also be interpreted as playing a role representing 'competition' from other 'suppliers'. The doubly-constrained model can be written as:

$$T_{ij} = A_i B_j O_i D_j f(c_{ij}) \tag{11}$$

where

$$A_i = 1/ \sum_j B_j D_j f(c_{ij}) \tag{12}$$

and

$$B_j = 1/ \sum_j A_i O_i f(c_{ij}) \tag{13}$$

T_{ij} is the interaction between zone i and zone j; O_i is the origin total of interaction flows out of i; D_j is the total interaction flows into zone j; c_{ij} is the cost of travel from i to j. The A_i and B_j terms may then be interpreted as Hansen-type accessibility indicators, each modified to account for competition (Wilson, 1967).

Out of the work on these kinds of gravity and spatial interaction measures has come a variety of extensions and modified or alternative frameworks. Koening (1980) for example, describes the behavioural approach to accessibility measures, based on utility concepts. A suitable expression for a behavioural foundation of accessibility, applied here to destination choice, turns out to be,

$$U_{ij}^{t} = V_{j}^{t} - c_{ij}^{t} + \varepsilon^{t} \qquad (14)$$

where U_{ij}^{t} is the utility associated by an individual t, living in i, with a destination in j; V^{t} is the gross utility of achieving destination j for individual t; c_{ij}^{t} is the generalised travel cost or time from i to j for individual t; and ε^{t} is a random term. The problem then is to specify a suitable probability function for the random variable ε^{t}. Koening (1980) describes a number of different methods for achieving this, including the hivex method (Koening, 1974, 1975) and the now well-known family of logit models (Domencich and McFadden, 1975, Ben-Akiva and Lerman, 1978, Weibull, 1976). For a more general review of accessibility and random utility see Williams (1976), Williams and Senior (1978).

All of these kind of accessibility indicators became popular in the 1970's especially in the field of transportation research, where researchers were keen to examine the land-use impact of changes in the transport network. For more discussion and various alternative expressions of accessibility see, for example, Black and Conroy (1977), Davidson (1977), Burns (1979) and Morris et al (1979).

There are at least two problems associated with any of the accessibility indices mentioned so far. The first is simply a restatement of an old problem: it is difficult to know how to weight them so that they can be combined. Experiment in a policy context is probably the only solution to this unless they can be converted into elements of consumers' surplus. This last suggestion is achievable for the travel component, but not in relation to the benefits offered by the facility reached.

The second problem is tricky, but may be solveable. In measuring access to opportunities, no account is usually taken of whether those opportunities can be successfully taken up. Consider, for example, the Hansen measure of accessibility to employment in equation (4). A_i measures the access to total jobs, but should perhaps be modified to take into account the probability of actually getting one.

A modified index could be constructed as follows. Let X_i be the number employed in i and Y_i the number unemployed. Let x_i and y_i be weights. Then

$$A_i = x_i X_i \sum_j E_j e^{-\beta c_{ij}} - y_i Y_i \qquad (15)$$

If y_i is given a substantial weight, then the $\{E_j\}$ distribution may become more important than the $\{c_{ij}\}$ distribution in the spatial pattern of $\{A_i\}$.

3.3.4 Benefit indicators based on consumers' surplus

Allied with the work on accessibility indicators have been other kinds of 'goal' indicators such as measures of spatial benefit, derived primarily in relation to welfare economics. The two sets of indicators are, however, often integral parts of the same study. Williams and Senior (1978, p 254-255) note that 'changes in accessibility indices are inextricably linked with changes in locational benefit accompanying a transport or land-use plan', (and see Gwilliam, 1972).

One such spatial benefit measure derives from the consideration of consumer welfare. The argument follows that of Wilson (1974a, 1974b) and we can focus on the location of retail facilities as a specific example. Competitive equilibrium from the retailer's point of view is likely to be very different from the consumer's optimal location pattern, or welfare equilibrium. This was demonstrated by Hotelling (1929) with his ice-cream men on a linear beach. The two equilibrium solutions are shown in Figure 14.

(a) (b)

Figure (14) Hotelling's ice-cream men on a linear beach

Figure 14 a) shows the welfare equilibrium with the ice-cream men at the first and third quartile points and hence consumers travelling the minimum mean distance. Figure 14(b), however, shows the competitive retailer's equilibrium which has resulted from each ice-cream man in turn moving nearer to the centre in order to obtain more than half the sales (Wilson, 1974a, p 263).

In real world terms, the location of retail facilities will be a mixture of these two forces and a set of others: the unequal spread of spending power and the benefits of agglomeration in terms of increasing returns to scale, for example. To account for this, Wilson suggested we should attempt to trade-off the benefits against the costs of travelling to retail outlets by maximising consumer's welfare. To explore this trade-off we need to write down the production-constrained shopping model on which the analysis is based:

$$S_{ij} = A_i e_i P_i W_j^{\alpha} \exp(-\beta c_{ij}) \qquad (16)$$

where

$$A_i = [\sum_j W_j \exp(-\beta c_{ij})]^{-1} \qquad (17)$$

and S_{ij} is the flow of revenue from zone i to zone j; e_i is the per capita expenditure on goods in zone i; P_i is the population in zone i; W_j is some measure of attractiveness (normally size) of retail facilities in zone j; c_{ij} is the cost of travel from i to j; α is a parameter that measures consumers'scale economies; β is a parameter reflecting ease of travel. Wilson (1974a) obtained a measure of benefit by writing

$$W_j^{\alpha} = e^{\alpha \log W_j} \tag{18}$$

and rewriting (16) as,

$$S_{ij} = A_i e_i P_i e^{\beta(\alpha/\beta \log W_j - c_{ij})} \tag{19}$$

It can then be seen that $\alpha/\beta \log W_j$ represents the size benefits of shopping at j and c_{ij} the disutility of travel. Thus each consumer needs to maximize $(\alpha/\beta \log W_j - c_{ij})$; and so the aim of planners might then be to maximize total consumer welfare (Z), where

$$Z = \sum_{ij} S_{ij}(\alpha/\beta \log W_j - c_{ij}) \tag{20}$$

(subject to any number of additional constraints).

Coelho and Wilson (1976) showed how this problem can be simplified and that the criterion in equation (20) is equivalent to the maximisation of consumers' surplus.

The idea of consumer surplus is a familiar one in economics.

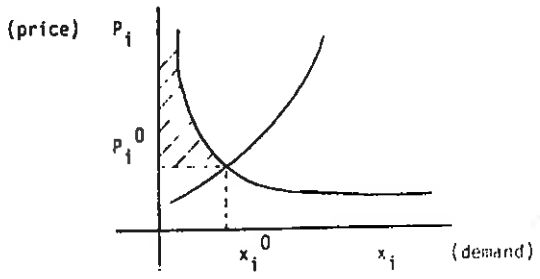


Figure 15 Consumers' surplus

The shaded area in Figure 15 is known as consumers' surplus since at any price greater than P_i^0, some people would still have been prepared to buy the good, and the shaded area represents the surplus of this group of consumers because the price is actually P_i^0 (Wilson, 1974a). Subsequent measures of benefit

(B) thus arise from changes in consumers' surplus (C.S.). If the price changes to P_i^1 then the shaded area in Figure 16 is the difference of the consumers' surplus in the old situation and in the new. From the area of the trapezium ABDC (Figure 16: after

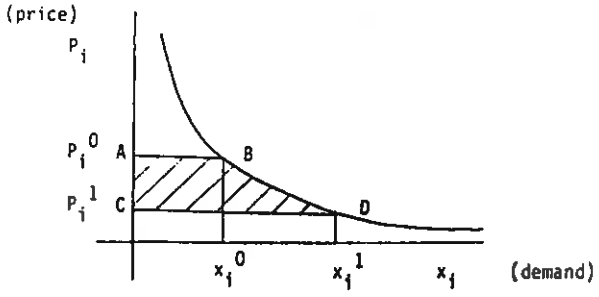


Figure 16 Change in consumers' surplus

making the chord BD a straight line) the benefit (ie. changing consumers' surplus) which results from a price change is measured as,

$$B = \Delta \text{ C.S.} = \tfrac{1}{4} \sum_i (x_i^0 + x_i^1)(P_i^0 - P_i^1) \qquad (21)$$

Wilson (1974, p 360-361) gives a simple example in relation to the transport sector, with a model that estimates T_{ij} (some flow total between zones i and j) as a function of C_{ij}'s (the cost of travel between i and j). If a transport facility reduces costs from C_{ij}^0 to C_{ij}^1 then the benefits of the new facilities are,

$$B = \tfrac{1}{4} \sum_{ij} (T_{ij}^0 + T_{ij}^1)(C_{ij}^0 - C_{ij}^1) \qquad (22)$$

(see also Tressider et al, 1968, the Selnec Transportation Study, 1972, and more generally Neuburger, 1971).

In terms of the shopping model introduced above, (equations 16 and 17), an equivalent maximisation problem based on consumer surplus turns out to be (cf. Coelho and Wilson, 1976):

$$\text{Max } Z = -1/\beta \sum_{ij} S_{ij} \log S_{ij} + \alpha\left(\sum_{ij} S_{ij} \log W_j - H\right) + \beta\left(C - \sum_{ij} S_{ij} c_{ij}\right) \tag{23}$$

subject to

$$\sum_j S_{ij} = e_i P_i \tag{24}$$

and

$$\sum_j W_j = W \tag{25}$$

where the variables are as before and C is the total money available for travel; H is a constant.

This model could now be used to optimise the location and size of retail facilities, with flows that are consistent with the spatial interaction shopping model (Coelho and Wilson, 1976).

Williams (1976) and Williams and Senior (1978) argue that for a 'wide class of spatial interaction models, computationally more efficient methods of generating the spatial benefits exist'. They look at the random utility maximisation approach and focus attention on location surplus, the utility gained at a particular location minus the associated transport costs.

Accessibility and benefit indicators have been introduced here since they form the basis for many studies on land-use and transportation changes. It has also been recognized for some time that many other 'goal indicators' could be developed. Indeed we saw some of these in the 'evaluation' section of 3.2.4. However, in terms of the kinds of models outlined above, little additional progress seems to have been made. New impetus now comes from two sources: first, we have seen much progress since 1978 with a class of theoretical problems concerned with the development and evolution of spatial structures based on just these kinds of spatial interaction models. Secondly, we are now facing an era where large-scale information handling and retrieving is no

longer such a painful prospect. Computer technology is advancing rapidly. What is required now is a new drive towards more efficient evaluation and monitoring techniques, based on these newer methods and advances in computer skills (though, as we have noted, this argument must be seen in a wider 'structural' context). This leads us on to look more formally at the performance indicator framework.

4 A new framework using a model-based approach

4.1 Introduction: systems, structures, processes and investigations

The review which has formed the basis of the first three sections of this paper reveals one striking feature at the outset: most previous approaches focus on individual zones and data associated directly with those zones - at whatever level of resolution; there is little attempt to take into account the systemic interdependencies which are likely to be vital in planning, and are likely to be important in many cases in the specification of the performance indicators themselves. Even the model-based studies of section 3 focus on accessibility, which is a zonal property or consumers' surplus, which is a whole-system one. The purpose of this section, therefore, is to work towards a new framework for the assembly of sets of urban performance indicators. It is possible to respond to the criticism just made by formulating a model-based approach. This will involve taking into account some relatively recent developments in modelling, and also responding to some of the critiques of modelling, whether 'liberal', phenomenological or structuralist. The discussion re-emphasises many of the issues raised in section 2.6 concerning the use of (area-based) indicators.

In the rest of this introduction, we introduce some key concepts which will form the skeleton of the framework and we relate these to the main critiques of modelling here at the outset. In section 4.2, we outline the recent advances in modelling which will support the proposed framework. In section 4.3, we illustrate the type of concepts to be used in developing a geography of performance indicators. Finally, in section 4.4, we draw the threads together and summarise the framework which by then has been assembled

implicitly.

Whatever the level of resolution of interest - from countries in an international system through to small areas within a city (cf. section 2.4) - we can consider the framework to apply to a system divided into spatial units - zones, with the objective being to provide indicators relating to zones within the system. In some cases, it may be appropriate to have a number of different zone systems - for example, one for the residential areas of a city, another relating to the facilities through which a service (such as hospitals) is provided. However, most features of any interest in any zone will be in some sense dependent on other zones, and the basis for presenting and understanding zonal performance indicators must reflect this. The framework must therefore be systemic.

Secondly, it is useful to distinguish the structures which are distributed between zones which support the basic activities and processes which represent the 'workings' of the system. It should be possible to link any definitions of performance indicators to all the relevant structures and processes. This analysis, therefore, provides two other key concepts: structure and process.

A framework which is connected to the ideas of system, structure and process involves handling the complex relationships which make up a typical study area, and it is not surprising that we seek a model-based approach to help. However, it is right also to recognise the limitations of this approach which, at times, can be severe and critical. We therefore add a fourth key concept: the approach should be investigative. This means that when model-based indicators suggest the existence of a problem (or, indeed, when the problem is identified from other kinds of evidence) then other means should be used, where appropriate to investigate it. The 'other means' can be related to the critiques of model-based approaches to which we now turn as a final preliminary.

There have been (at least) three kinds of criticism of modelling as a basis for planning and it is important that these should be addressed in any proposal for a model-based performance indicators framework. They derive from a liberal position (as with Lee's,

1973, 'Requiem for large scale models'), phenomenology (as represented by, say, Relph, 1976, and summarised more broadly by Johnston, 1983) and structuralism (sometimes of the Marxist variety, as in Harvey 1973, 1984, Massey 1984.)

The first of these is an argument against the capabilities of large-scale modellers and an assertion of their inability to confront the most important problems of planning. The first part can to some extent be countered by developments in modelling in the last ten years; the second can be seen as part of the broader 'radical' critique. There is considerable substance in the argument and the focus on performance indicators in this paper is in part an attempt to confront it.

The phenomenologist argues for a more humanist-centred focus, with the admission of, in the present context, the subjective experiences of individuals as an important part of the evidence on problems. This again raises the issue of subjective indicators addressed in section 2.6. Despite the problems of measurement and interpretation associated with such indicators this part of the critique has to be accepted and it is intended that it should be part of the 'investigations' which represent the second phase of any performance-indicator-based planning study.

The structuralist is likely to argue that modelling is positivist and functionalist and is likely to be concerned with 'surface observation', symptoms rather than deeper causes. The Marxist will argue, in addition, that the assumptions of neo-classically-based modelling are simply wrong. This in part, and where appropriate, demands further developments in modelling. On the whole, something like modelling techniques will still be needed in more structuralist approaches because it will always be necessary to find ways of handling high levels of complexity.

In summary, then, much of the spirit of the radical critique has to be accepted. We will seek to respond in two ways: first, by continuing to deepen the theory which is at the basis of modelling; and secondly by recognising that there will always be a second investigative phase of planning work which goes beyond the model-based analysis. The conclusions can best be summarised in

terms of Habermas' three kinds of 'communicative interest': the 'technical', which is in this case connected to what can be achieved by a 'scientific' approach; the 'practical', a concern with interpretation and meaning in related discourse; and, above all, the 'emancipatory'. The goal of all performance-indicator based studies should be gains in emancipation of some kind; and Habermas' second two 'interests' together imply that it will be necessary to recognise and rise above hidden ideologies in the frameworks which are developed. Modellers have to show that they can learn to be as capable of this as anyone else.

In practice, this will involve recognising different categories of planning problems: those which are technical and relatively well-defined; those which are not so well understood and which need interpretive studies; and those which involve power relationships in hidden ideologies. We will aim to show that the 'technical' and 'well-defined', with appropriate extensions in modelling methods and insights, can provide appropriate foundations for planning studies in a greater variety of cases than is often thought.

4.2 Advances in modelling

4.2.1 Structures and processes

For most of the history of urban modelling, it has only been possible to deal with population forecasting and population activities - transport, residential location, choice of workplace and use of services - and to a lesser extent with economic activities and associated prices. More recently, it has become possible to model those sectors of the 'supply side' which determine the physical infrastructure and the 'form' of cities (cf. Harris and Wilson, 1978, Wilson, 1981, Clarke and Wilson, 1983 for examples). This makes it more nearly possible to understand the determinants of urban structure, and hence the way in which particular patterns of performance indicators come about - such as the 'inner city' problem in many British cities.

To this can be added the beginnings of a capacity to build dynamic models which represent cities in disequilibrium and whose

workings are connected to theories - from whatever source, not necessarily neo-classical - which focus on the variety of processes which make up the sum of urban activities. It is in this area that there is the possibility of drawing together the insights of contemporary modelling and both theoretical and empirical studies of the radical school.

These new approaches offer new broad insights which change the form of the potential contribution of modelling. In particular, they expose the great variety of possible equilibrium 'solutions' which are available at any one time - one or more of which will be influencing development even when the city is not in equilibrium. The particular solution or trajectory which is dominant will be determined by a combination of the 'forces' which can be articulated in the model and the particularities of specific situations - with 'historical accidents' and individual agents often playing crucial roles. In most cases, therefore, it is no longer possible to think of models as supplying the means of conditional forecasting as part of an impact analysis (as described in section 3.2.3) they can be used to help to interpret history and to chart possible futures. It may even be possible to use the knowledge gained to advocate policies which will shift a city from one trajectory to another - but probably to a new 'structural type' or 'trajectory type' rather than a detailed scenario.

4.2.2 Micro-simulation

As modellers have become more ambitious and have attempted to incorporate both higher levels of interdependence and more detail, the traditional mathematical representations - arrays with many indices - break down in practical forms by demanding too much computer storage. This problem has been overcome by the development of so-called micro-simulation methods (see, for example, Clarke, Keys and Williams, 1980, 1981 and Clarke 1981). This involves building a hypothetical population of individuals with characteristics such that the overall population looks as much like the real one as possible; and projecting this through time. The method can be seen as a technical device for handling high levels of detail, but is potentially particularly important

in relation to performance indicators because, in suitable circumstances, impacts can be calculated at the same level of detail - the sets of individual characteristics being used as the basis for calculating the indicators.

4.2.3. Extended comprehensive models

The presentation so far on modelling has focussed on increasing capability in relation to two of the key words used in this section: 'structure' and 'process'. Here, we simply note briefly that the expansion of technique and substantive coverage imply that extended comprehensive models can be built, using conventional or micro-simulation (or mixed) representations. This means that if performance indicator calculations can be related to this kind of framework, then the potential for coping with systemic effects is also increased.

4.2.4 Model-based information systems

It is clear from the review, particularly in the first two sections, that most performance indicators have been calculated directly from data; and they are correspondingly limited. In the context of this paper, models can be usefully seen as filling in 'gaps' in data bases, so that data and model outputs together constitute an expanded information system which can then provide the basis for performance indicator calculations. In a sense, therefore, the rest of the argument can be seen as an attempt to provide a design for such an information system, with modelling methods providing inputs, and the outputs being performance indicators.

4.2.5 Further extensions needed

The overall picture is not, of course, as rosy as is being painted: the dynamic structural and process-oriented models need much further empirical development (though significant strides are now being made, as in G P Clarke, 1986); perhaps even more importantly, there are many features of cities which, it is intuitively clear, should figure prominently in any account of

quality of life which do not figure very much in available models. Developments in the first of these two areas have begun and will continue; it is hoped that advances in the second can be stimulated by building on what is required in the calculation of performance indicators, and so this will figure prominently in the rest of the paper.

Two examples will illustrate the kind of development which is needed. The first arises on both counts and is particularly difficult: that is, a concern with economic development, particularly connected to the future of employment opportunities and unemployment. The second example will be seen to arise from any analysis of performance indicators which adequately reflect quality of life: that is a concern with money flows (or other costs and benefits in kind) in cities so that we can improve our understanding of how the variety of individual real incomes are determined. In this case, it is probably a neglect of modellers of a crucial area rather than intrinsic theoretical difficulty which is at the root of the issue. We will therefore re-appraise the extensions needed in the light of our presentation of a framework for performance indicators. The framework will be presented in section 4.5 and the associated research agenda, including model extensions, in section 5. First, however, we tackle one further preliminary with a discussion of some general conceptual aspects of performance indicators in the next section.

4.3 The geography of performance indicators

At a most general level, it is possible to consider cities as made up of two interacting sets: the individuals in the population and the organisation of all kinds which make up the urban economy - the latter category being interpreted in the broadest possible sense. Then some indicators will relate directly to the residential 'environment' of households; others directly to the 'performance' of organisations (the equity v efficiency argument of section 2.6) but many will depend on the mutual interdependence, the effectiveness of 'delivery' of jobs, goods and services to members of households from the location of organisations to residential locations.

This kind of scheme has been worked out in some detail and used in relation to health services (cf. Clarke and Wilson, 1984, 1985a), butit can be applied more generally (as argued in Wilson, 1986a). This aspect of public service provision can usefully be articulated first, and then we can combine the indicators thus generated with others.

Let P_i^m be the population of type m resident in zone i and let Z_j^g be some measure of the supply of service g by some public organisation in zone j. Let N_{ij}^{mg} be the use of g in j by m-type residents of zone i. Let C_j^g be the (say annualised) expenditure on g in j. Then it is possible also to calculate the <u>catchment population</u> of g at j: this is the share of the total population whose needs are in principle met by the part of service g which is delivered from j. Denote this by π_j^g. We can also suppose that

$$\hat{Z}_i^{mg} = \sum_j \frac{N_{ij}^{mg}}{N_{*j}^{mg}} Z_j^g \qquad (26)$$

and

$$\hat{C}_i^{mg} = \sum_j \frac{N_{ij}^{mg}}{N_{*j}^{mg}} C_j^g \qquad (27)$$

are notional quantities and expenditures of good g respectively used by m-type residents of i. We then distinguish residential-zone performance indicators, such as

$$\hat{Z}_i^{mg} / P_i^m \ , \ \hat{C}_i^{mg} / P_i^m \qquad (28)$$

from facility - or production - zone performance indicators

$$Z_j^g / \pi_j^g \ , \ C_j^g / \pi_j^g \qquad (29)$$

It is straightforward to characterise the first of these types as concerned with <u>effectiveness of delivery</u> (and also with <u>equity</u>); and the second with <u>efficiency</u>. And so we can re-stress the new perspective on the equity-efficiency problem. (Note that, in principle, and sometimes in practice, the i-zone and j-zone

can be different).

The definition of the variable P_i^m is likely to be crucial in the equity-efficiency issue. One of the problems of an indicator based study highlighted in section 2.6, was the so-called 'ecological fallacy' of attributing average conditions to the entire population of the area under study. Whilst the focus on homogenous populations may be useful in exposing general levels of welfare or deprivation, it is important to appreciate these will vary between different sections of the community. Indeed, most of the urban problems of today could be classified in terms of gender, class and race and the often unique problems each of these groups face. The Women and Geography Study Group (1984), for example, explore the restrictions on access to facilities by women, especially those caring for young children who have specific problems of mobility and hence demands on local facilities.

We have thus distinguished two very different aspects of performance indicators in cities. This is achieved by focussing on interaction, and then distinguishing catchment population from residential population to provide a divisor to assess the performance in relation to production as something different from performance in relation to delivery.

The obvious planning task within a service sector, g, is to ensure that the spatial distribution of provision and expenditure, $\{Z_j^g\}$ and $\{C_j^g\}$ are such that <u>both</u> sets of effectiveness and efficiency indicators achieve appropriate targets. (In many situations it is possible to achieve neither; but in many others, one rather than the other.)

In the case of marketed goods and services, it is possible to use, in addition, revenue attracted to g-type organisation in j as part of performance assessment - D_j^g, say. Indicators like

$$D_j^g / Z_j^g \quad \text{and} \quad D_j^g / C_j^g \tag{30}$$

will then be appropriate. In this case, the ability of

individuals to purchase will obviously be dependent on income; and incomes will, in the main, be dependent on another function of the city in relation to its people - that is, a supplier of jobs.

In all these cases, it may be important in some way to distinguish the quality associated with residential environments and the goods and services provided. We also need to distinguish the transport costs (in some 'generalised' sense) incurred by individuals in 'using' the organisations of the city.

We can then begin to build up a broad picture of the set of performance indicators to which this argument leads. They are summarised in Table 2.

TABLE 2 'Sets' of performance indicators

Residence-based

Household incomes
Quality of housing and residential environment
Work opportunities
Take up of marketed goods and services
Take up of public goods and services
Transport (generalised) costs

Organisation-based

Efficiency of production
Role in labour market
Transport costs associated with inputs and outputs

We have seen that, usually, it will be important to base the definition of many of the indicators of both types on the actual levels of interaction between households and organisations; and this fundamentally changes the usual approach, which is more likely to be based on residential zones alone. This argument therefore establishes the principles on which we can proceed and we now make some recommendations for a framework which is consistent with these in the next section, and we compare the result to the illustrations we presented of alternative frameworks earlier in the paper.

4.4 A new model-based approach

4.4.1 Introduction

The previous argument has shown that most existing indicators are calculated in relation to data; and in relation to single zones with little reference to other zones. Many of the indicators are not directly related to what we want to measure - 'quality of life' in some way. We have suggested that a model-based approach can be used to make us less reliant on data availability - model predictions can be used to fill 'gaps'. It can be focussed onto zonal properties which depend crucially on interdependence with other zones - job opportunities, availability of services, and so on. It can be focussed directly on people and organisations rather than 'areas'. In addition, the indicators are calculated from variables which are systemically related and are directly connected to our knowledge of urban structure and processes. In the previous section, we gave a general account of these ideas. The task now is to show in some more detail what is involved in implementing them.

The starting-point is Table 2. We take each of the headings in that table and explore what would be involved in the operational definitions of associated indicators. This will also enable us to be more precise about the model extensions which are needed. We take in turn 'individuals', 'organisations' and, as an addition to the table, 'areas'. As a preliminary, however, we sketch the model system which is needed.

4.4.2 The requirements for a model system

Consider Figure 17 (from Clarke and Wilson, 1985b), which shows in outline the kind of comprehensive model which can in principle be built. It involves distinguishing population and population activities, the economy and economic activities and the infrastructure (including 'land use' and hence the 'spatial form' of the city). The economy can be considered to function in interacting sectors, and needs to be modelled as such. But the diagram also shows that the 'outcomes' of economic organisation

can be collected together in relation to their roles in population activity: housing, job provision and service provision.

At any point in time, we have a starting position: the city as it is. Historical processes will have determined the allocation of people to houses and jobs, and service provision and it should be possible in principle to understand a current structure in these terms; and also to generate some ideas about change.

Typical variables which will be used to construct this kind of model system are shown, with a key, in Figure 18 - also based on Clarke and Wilson (1985b). The crucial labels are: person types, m; household types, h; and sectors (and, e.g., services), g. In each of these cases, the simple index can be considered to be a list if appropriate. For example, m might be expanded to (w, b) = (income, occupation), with 'occupation' carrying connotations of degrees of skill, the understanding of which would need modelling of the educational subsystem. These categories should be defined in such a way that they help us to build a labour market model, so that job availability could also be defined in relation to w and b. That is, we need to relate residential-zone arrays like P_i^{wb} to economic-zone arrays like E_j^{gwb} - the latter being the number of (w, b) jobs in sector g. Some means would have to be found then for assigning (w, b) workers to h-type households so that, for example, household incomes could be computed. Such a model would also have to identify sources of income which did not derive from employment.

This sketch provides a starting point. It will be expanded as we discuss the requirements for the construction of each indicator type in turn.

4.4.3 Individuals and households

It is also useful at the outset to recognise that it is necessary to define households, since some individual features are often crucially combined at that level: two-income households, for instance, to be compared to single-parent non-working households.

Incomes. Because incomes are not directly available from data, traditional indicators have been based on car ownership, socio-economic group, and so on, in an area. What is needed is a direct identification of the source of incomes and the ways these are combined in households. We saw in the preceding subsection that we can expect to calculate, in a model, arrays such as p_i^{wb} and E_j^{gb} and the labour market resolution, say T_{ij}^{wgb}. The latter array refers, obviously, to those who actually find a job. It is also necessary to calculate (say) a probability p_i^{wb} that someone in the (w, b) group in zone i actually has a job. (There are difficult issues of dynamics here which can be handled but will be neglected for simplicity for the time being - for instance that the probability of living i at a particular time will be dependent on previous employment history). Then if $\hat{I}_j^{gb}$ is the average annual wage or salary of the (g, b) groups in j, then $T_{ij}^{wgb}\ \hat{I}_j^{gb}$ is the amount taken back to i by the (w, b, j, g) group. By computing unemployment from p_i^{wb} and $\bar{p}_i^{wb}$, and relating (w, b) potential workers to their household structures, it should also be possible to calculate social security income (as well as income derived from 'wealth'). The outcome of a complicated submodel would be an estimate of (say) I_i^h, the average annual income of a type h household in zone i. If aggregate area indicators were required, they could be computed; but it is much more effective to have the array $\{I_i^h\}$ together with the $\{T_{ij}^{wgb}\}$ elements which provide a rich source of additional information on where the different kinds of income derive from. However, it should be recognised that the emphasis on income is a new focus for this style of urban modelling.

Quality of housing. Typical indicators would be number of houses with various inadequate features. The crucial step in making further progress is to identify housing categories k which actually reflect quality. Ideally, this should be some physical measure; in practice, it may be better to take 'notional rent' intervals - 'corrected' to allow for spatial variations in otherwise equivalent housing. We then need from the data and models H_i^k, the number of type k houses in i, r_i^k, the notional annual 'rent' and T_i^{hk}, the number of type h households resident in type k houses in i. This array is a rich source of information. If we could define k_c as some cut-off category in k 'below which' the housing standard

was unsatisfactory, then it would also be possible to calculate aggregate zonal indicators like $\sum_{h,k \leq k_c} T_i^{hk} / \sum_{hk} T_i^{hk}$, the proportion of households in i living in substandard housing - but again, the more detailed information is better. It could be coupled with the T_{ij}^{wgb} arrays so that the sources of the income which supported different types of resident in i could be investigated.

Work opportunities. A typical indicator would be zonal unemployment. As usual, we seek more detail. The main relevant information is contained in P_i^{wb}, as an estimate of the potential workforce in i and T_{ij}^{wgb}. However, it would also be interesting to use the argument of section 4.3 and to calculate

$$\hat{E}_i^{gb} = \sum_j \frac{T_{ij}^{*gb}}{T_{*j}^{*gb}} \cdot E_i^{gb} \qquad (31)$$

is a measure of the (g, b) 'available' jobs of residents of i (where an asterisk, as usual, denotes summation). Then indicators like $\hat{E}_i^{*b}/P_i^{*b}$, the b-jobs available in i per available worker, are important. The different elements in the sum on the right hand side of (31) provide important additional information on the sources of these jobs.

Marketed goods and services. The usual indicators are shops (possibly by type) per head of population, which are grossly inadequate in relation to interaction; and accessibilities, which are better but still not highly informative. As by now usual, we can improve the situation by constructing new indicators based on an interaction model - and indeed following the argument of section 4.3. It is instructive, however, to articulate the argument explicitly for service types g, population types m and an interaction array $\{S_{ij}^{mg}\}$. Let e_i^{mg} be per capita 'demand' and P_i^m the resident m-type provision; let W_j^g be the scale of provision of g at j (and assume, for simplicity that this can function directly as a measure of attractiveness). Take c_{ij} as transport cost. Let α^m and β^m be scale and distance parameters (assumed to vary with person type). Then a standard argument (cf. Wilson, 1974a) generates the following model:

$$S_{ij}^{mg} = A_i^{mg} e_i^{mg} P_i^m (W_j^g)^{\alpha^m} e^{-\beta^m c_{ij}} \tag{32}$$

with

$$A_i^{mg} = 1/\sum_j (W_j^g)^{\alpha^m} e^{-\beta^m c_{ij}} \tag{33}$$

$$\pi_j^{mg} = \sum_i \frac{T_{ij}^{mg}}{T_{i*}^{mg}} P_i^m \tag{34}$$

serves as a measure of catchment population for g at j (for m-people), and

$$\pi_j^{*g} = \sum_w \pi_j^{wg} \tag{35}$$

is a total catchment population for j at g.

$$\hat{W}_i^{mg} = \sum_j \frac{S_{ij}^{mg}}{S_{*j}^{mg}} W_j^g \tag{36}$$

similarly serves as a measure of service availability at i (for m, for g). As before,

$$\hat{W}_i^{*g} = \sum_m \hat{W}_i^{mg} \tag{37}$$

It was also shown in Wilson (1974a)

$$b_{ij}^{mg} = \frac{\alpha^m}{\beta^m} \log W_j^g - c_{ij} \tag{38}$$

can be interpreted as a measure of the net benefit gained by a w-resident of i using j for service g.

If S_{ij}^{mg} is in money units (via e_i^{mg}), then

$$D_j^g = \sum_{iw} S_{ij}^{mg} \tag{39}$$

is a measure of the total revenue attracted to j for g.

Appropriate residential zone indicators are then ratios like $\hat{W}_i^{mg}/P_i^m$, $\hat{W}_i^{*g}/P_i^*$, $\sum_j b_{ij}^{mg}/P_i^m$ and $\sum_{jw} b_{ij}^{mg}/P_i^*$. The individual terms in the summations (36) and (39) help to show from where the benefit derives. We will make use of some of the other concepts introduced

here when we turn to organisations below.

It may also be appropriate to examine

$$C_i^{mg} = \sum_j S_{ij}^{mg} c_{ij} \qquad (40)$$

the total travel costs by w-residents of i for g; but this is one component of total benefit.

Public goods and services. In the residential zone case, the argument exactly parallels that of the one above for marketed services except that the units will not be financial. So a combination of section 4.3 and the preceding subsection makes the desired points.

Transport (generalised) costs. In general, it is best to consider transport costs in association with particular sectors (as in (40), in relation to services, above). However, if it is transport policy itself which is under scrutiny, or it is thought that transport planning can contribute directly to other objectives, then it will be appropriate to construct indicators based on the different components of generalised cost. (This argument is presented in detail in Wilson, 1985).

Composite measures. In many cases, particularly when indicators show a provision well below some accepted 'standard', problems can be identified by 'single sector' analysis. In many cases, however, indicators can only be considered in combination: wealthy commuters incur high transport costs to gain the advantage of a particular residential environment. Such a cost indicator should not necessarily suggest a 'problem', therefore. Ideally, what we need is a composite measure, analogous perhaps to the economists' utility function:

$$\begin{aligned} \text{Utility} = {} & \text{Residential utility} + \text{job utility} + \Sigma\ \text{Service} \\ & \quad \text{utilities} \\ & - \Sigma\ \text{travel disutilities} \\ & - \text{Money costs of housing, services and transport} \\ & + \text{Residual income} \end{aligned} \qquad (41)$$

The first four terms represent some attempt to measure utility directly, the next the associated costs, and finally, residual income. This notion also begins to introduce the effects of market processes (where appropriate) in otherwise similar components of giving utilities different values at different locations.

4.4.4 Organisations. Efficiency of production

Ideally, efficiency has to be discussed in relation to a detailed knowledge of the processes of production - in effect, the production function. This, of course, is complicated by the effect of location and interactions with both suppliers and markets; and also because large organisations are themselves distributed in a variety of units across space. This detailed knowledge is rarely available; and there is also a problem of scale. Ideally, as the title of the section implies, we need to focus on individual organisations - but effective data at this scale is rarely available. We have to make the best of what is available for 'sectors', probably zonal totals of some kind. We need to find indicators, then, which act as proxies for the production function: in a non-marketed sector volume of service supplied (e.g. hospital beds) per head of catchment population, or per head of resource inputs; in a marketed-sector, the list extends to include indicators involving revenue - such as profit, profit per units of input, and so on: recall the indicators of the N.C.B. and the National Bus Company in section 2.5.

Role in pattern of provision. The problem to be tackled here is not one which has been seriously investigated in the literature (outside the consensus of the traditional narrowly-defined equity-efficiency problem). But we can now use the concepts of section 4.3 to make progress. The main issue is this: it is possible to be efficient and still to be ineffective in delivery. That is, indicators like Z_j^g/π_j^g may show efficiency, but it is also necessary to look at the contributions which Z_j^g makes to each of $\hat{Z}_i^g$ and to examine delivery indicators like $\hat{Z}_i^g/P_i^*$. It is in this sense that we need to characterise the role of any particular Z_j^g in the wider spatial system.

Role in the labour market. The argument can be repeated with employment totals E_j^{gb} replacing product/service outputs, Z_j^g. We can define role in terms of the contribution of each E_j^{gb} to $\hat{E}_i^{gb}/P_i^*$.

4.4.5 Areas

In the past, indicators have largely referred to areas rather than to individuals, households or organisations. We can now return to this topic and suggest that it is still useful to develop area profiles, and we proceed to do this under three headings.

Type. Traditional analyses, as we have seen, have been focussed on an areas 'type' in some way; and the apogee of this style of work was probably achieved in factor analysis. Such analyses will remain useful, especially immediately after a census with a mass of new data, or to make a quick assessment of the structure of a city. In the argument developed here, we would expect to build up a 'type-profile' simply by enumerating for each zone the main model variables: P_i^m, E_j^{gb}, Z_j^g and so on. (A useful addition would be measures of environmental quality.) It may also be possible to summarise 'type' by focussing on the range of household utility functions exhibited in each zone, though this to some extent overlaps with the idea of 'role' which we pursue next.

Role. We can further develop the concept of 'role' introduced in relation to organisations above. In effect, we summarised in relation to 'type' the people and organisations which make up different zones in a city. The next step is to use the interaction variables to assess the role a zone plays in the labour market, the service market, and so on - so focussing both on demand and production in each zone, not just on production as in section 4.4.4.

Balance. Finally, we introduce the elusive concept of 'balance'. Various flows into and out of each zone, particularly economic flows, have to be balanced through accounts (in an analogous way to the more familiar example of a country as a whole). (The

nearest traditional indicator in this area is something like 'unemployment'.) However, this is not a field in which modellers have excelled. But an attempt to convert all interactions into corresponding money flows, and to build the results into accounts, would be very fruitful and would further develop the notion of 'role'.

5. Concluding comments

The potential for the kind of analysis discussed in section 4 has been available for a long time. But little progress has been made because (as section 2 and 3 show) social scientists working on indicators have been largely unconnected to modelling; and modellers have not paid much attention to the way in which indicators can be constructed from model outputs (other than the direct forecasts). We are therefore implicitly recommending that these gaps should be filled and that a model-based approach is appropriate. The steps involved can be summarised in broad terms as follows.

(1) A wide rnage of p.i.'s should be calculated from model outputs as a matter of routine.

(2) It should be possible to be more inventive in defining new p.i.'s - for example from the implied utilities in different submodels.

(3) It would be instructive to extend models to focus more explicitly on income and other money flows. This would facilitate the definition of useful new p.i.'s.

(4) As a matter of routine, it is possible to define p.i.'s now so that good profiles can be built up of population groups, sectors and areas within a city.

(5) It may be fruitful to investigate the concept of 'balance' in relation to population, sectors and areas.

(6) The p.i.'s should be related to, and interpreted in terms of, planning problems and ways of solving them. At this point, it is particularly important to recall the systemic basis from which the p.i.'s were constructed.

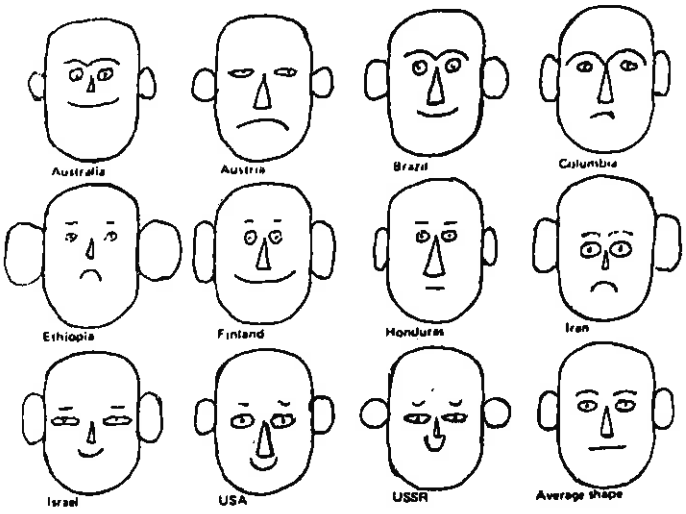
(7) At all stages of this kind of analysis, it is vital to seek the deepest levels of explanation. An 'indicators focus' may

provide a useful bridge to connect modelling to other styles of theorising.

	Indicator name	Variables used in calculation	Conversion	Method of combination
1	Relative availability of student places at consecutive levels	Ratio of enrolments at pre-school to first-level Ratio of enrolments at special education to first-level Ratio of enrolments at second-level to first-level Ratio of enrolments at third-level to second-level (each ratio separately for males and females)	1. Index numbers 2. Standard scores	unweighted average
2	Relative availability of classes at consecutive levels	Ratio of numbers of classes at pre-school to first-level Ratio of numbers of classes in special education to first-level Ratio of numbers of classes at second-level to first-level Ratio of numbers of classes at third-level to second-level	1. Index numbers 2. Standard scores	unweighted average
3	Relative availability of schools at consecutive levels	Similar variables to those above except numbers of schools are used instead of numbers of classes	1. Index numbers 2. Standard scores	unweighted average
4	Development emphasis on quantitative expansion of system for students (4), classes (5) and schools (6)	Rates of change for all variables listed for indicators 1–3	1. Index numbers 2. Standard scores	unweighted average
7	Female involvement in the provision of education	Percentages of enrolment who are female at the first-, second- and third-levels Percentages of teaching force who are female at the first-, second- and third-levels	1. Index numbers 2. Standard scores	unweighted average
8	Diversification of second-level studies	Percentages of second-level students enrolled in general education and teacher training courses	No	C index
9	Orientation of third-level studies	Percentages of third-level students enrolled in nominated fields	No	1. C index 2. Ratio of C values
10	Expected number of years of education received by an entrant	Promotion and repetition rates for all grades in the first-level and/or second-level	No	Special formula (Equation 3.15)
11	Expected number of grades of education completed by an entrant	Promotion and repetition rates for all grades in the first-level and/or second-level	No	Special formula (Equation 3.17)
12	Availability of qualified teachers	Percentage of teachers in various qualification categories	No	C index
13	Distribution of qualified teachers	Percentages of qualified teachers in each area of a country as well as percentages of total teaching force in each area	No	Gini coefficient
14	Male/female educational flow differential	Promotion and repetition rates for each grade for males and females separately	No	Special formula (Equation 3.17) then division
15	Regional educational flow differential	1. Promotion and repetition rates for each grade in each region 2. First and final grade enrolments and total enrolments for the level analysed	No	1. Special formula (Equation 3.17) + standard deviation 2. Ratio of Gini coefficients
16	Index of structural differentiation	Variety of characteristics of institutions	No	Guttman scale
17	Dependence on a single fund source	Percentages of all expenditure on a system provided by the national government of a country and by state or provincial governments	No	C index
18	Education cost indicator	Unit costs for first-, second- and third-level over a given time period and enrolments at each level in a base year	Index numbers	Laspeyres formula

Figure 1 Summary of the core indicators for the process sub-division of education systems

Source: Johnstone (1981, p. 165)



Facial characteristic	Empirically defined indicator number	Interpretation
Width of mouth	1	The wider the mouth, the more extensive is basic educational development.
[illegible] mouth	2	The greater the smile, the more extensive is female involvement in educational provision.
[illegible] ears	3	The longer the ears, the greater the development emphasis on second-level education.
Width of ear	5	The wider the ear, the greater the development emphasis on providing an equality of involvement for female pupils.
Overall size of nose	4	The larger the nose, the greater the proportion of third-level enrolments in law/social science courses. The smaller the nose, the greater the proportion in humanities/education/fine arts courses.
[illegible] ture of eyebrow	7	The greater the upward curvature of the eyebrows, the greater is the emphasis on expanding teacher education facilities.
[illegible] size of eye	6	The more open the eyes, the greater the proportion of second-level enrolments in the general education stream.
Extent of slant eyedness	8	The more slant-eyed, the greater the relative extent of pre-school provision.
Distance between pupils	10	The further apart the pupils, the greater the proportion of third-level students in natural science courses.
Position of eye	9	The lower the position of the eyes, the higher is the general quality of educational provision.

Figure 2 Representation of empirically defined education system characteristics: selected nations for 1960

Source: Johnstone (1981, p. 221-222)

Figure 3 Selected measures of activity and provision in health services

(i) Admission rates per specialty per 1000 population

(ii) Average length of stays by specialty

(iii) Throughput as measured by discharges per bed per specialty

(iv) Percentage bed occupancy by specialty (occupied beds expressed as a percentage of available beds)

(v) Operation rates per 10,000 population by specialty

(vi) Admissions to surgical beds per 10,000 population

(vii) Ratio of admissions resulting in operation to all admissions in the surgical specialties

(viii) Number of laboratory technicians and radiographers per 10,000 population

(ix) Inpatient radiography units per 1000 discharges

(x) Provision of operating theatres per million population

(xi) The number of discharges in surgical specialties per operating theatre

(xii) The number of surgical beds per operating theatre

Source: Logan et al (1972). Cited in Goldacre and Griffin (1980, p.30)

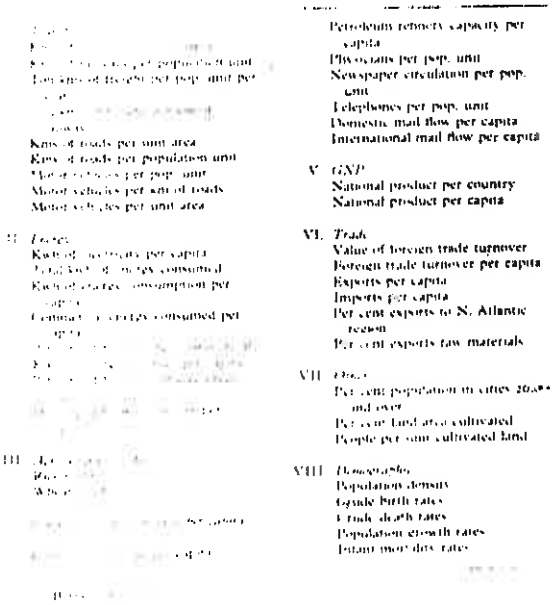


Figure 4 Indices selected by Berry as significant to the analysis of economic development

Indicator	Sign
1 Gross reproduction rate	
2 Population density	
3 Dependence ratio	
4 Illegitimacy rate	
5 Public expenditure on education as % of GNP	
6 Students per 100,000 population	+
7 Per cent of students female	+
8 Hospital beds per 1,000 population	+
9 Doctors per 10,000 population	+
10 Protein consumption per person per day	+
11 Infant mortality rate	−
12 Late foetal death rate	−
13 Stomach ulcer death rate	−
14 Suicide rate	−
15 Motor accident death rate	−
16 Telephones per 100 population	+
17 Radio receivers per 1,000 population	+

Source: King (1974). Positive signs indicate that high values are "good" and low values "bad"; negative signs indicate the reverse.

Figure 5 Indices used to measure 'social progress' 1951-1969

Figure 6 **SPES Indicators Tableau 1976 (Abridged Version)**

Goal level/ goal dimension	Corr. No.	SPES indicator 1976	Dimension	1950	1960	1965	1970	1975	Welfare development 55/old old 65/70 70 75	Indicator	Area district unit
0. Population											
1 Population growth	1	Population growth (per year)	%	1,10	1,20	1,21	0,38	-0,36			
	2	'Natural' population growth	1000	238	326	367	92	-149			
	3	Foreign population rate	%	0,90	1,32	2,05	4,91	6,65			
	4	Difference to 'stationary' population	a)		11 3	10 1	11 3	11,1			
	5	Net reproduction figure	a)	0,95	1,11	1,18	0,93	0,71			
2 Household structure	6	3- and 4-generation households	%	7,3	5,6		4,9	3,8			
	7	Part of population in big households	%	39,5	36,7	34,1	27,3	23,9			
	8	Part of population in one-person households	%	8,8	9,6	12,3	12,6	14,1			
	9	Institutionalized population	%		2,4		2,1				
3 Family structure	10	Marriage rate, females aged 35-45	%	77	80	86	87	87			
	11	Ave. first marriage age, females	Years	24,4	23,7	23,7	23,8	23,9			
	12	Illegitimate birth rate	0/00	79	63	69	55	63			
	13	Divorce rate	0/000s	23	36	39	51	57			
	14	Remarriage rate, female	0/00s	91	59	62	62	59			
	15	Incomplete families	%	31	32		31	32			
	16	Families with unmarried children	%	43	45		49	51			
	17	One-child families	%	28	28		24	23			
	18	Families with 4 and more children	%	4,2	3,8		4,2	3,7			
	19	No. of third to 1,000 second children	n	552	519	503	412				
	20	Ideal no. of children (survey)	n	2,3	2,3		2,3				
	21	Widowed over 65: females/males	/1000		3361	4277	4936	4942			
4 Assistance burden on active population	22	Non-working/working rate	%:1	106	111	119	120	130			
	23	Children under 6/100 in labor force	%:1	18	20	22	22	16			
	24	Students/100 in labor force	%:1	36	35	36	43	49			
	25	Old age (f. 60, m. 65)/100 in labor force	%:1	28	31	33	38	41			
5 Migration, agglomeration	26	Population density in central cities	p./sq.km.		2196		2223				
	27	Part of population in central cities	%		36,1		33,9				
	28	Population growth in central cities	%	} 1961 bis 1970			(1,2)				
	29	Population growth in urban area	%				(28,1)				
	30	Population growth in suburban area	%				(30,1)				
	31	Domestic migration rate	0/00	65,8	60,1	66,0	68,4	55,3			
10 Social Status and Mobility											
1 Socio-economic status	32	Agricultural population	%		13,5		6,9				⊙
	33	'Old' middle class	%		8,1		7,1				
	34	'New' middle class—white-collar	%		22,5		29,1				
	35	'New' middle class—civil servants	%		7,0		9,2				
	36	Working class	%		51,0		47,3				
	37	Old-age pensioners	%				10				
2 Amount of mobility	38	Mobility rate	a)%		70		72				
3 Upward mobility chances	39	Upward mobility semi-skilled workers	a)		6,0		6,9				+
	40	Upward mobility unskilled workers	a)		6,0		7,4				+
4 Downward mobility chances	41	Downward mobility semi-skilled workers	a)		19		19				−
	42	Downward mobility unskilled workers	a)		7		8				−
5 Structural mobility	43	Structural mobility—skilled workers	a)		± 21		± 11				
6 Social stability	44	Immobility rate—skilled workers	a)		43		43				+
7 Social heterogeneity	45	Heterogeneity rate (inflow)—skilled workers	a)		64		63				+
8 Equality of opportunity	46	Inequality (association) index—skilled workers	a)		1,6		1,5				+
	47	Conditioned inequality—skilled workers	a)		1,1		0,1				+

Figure 6 continued

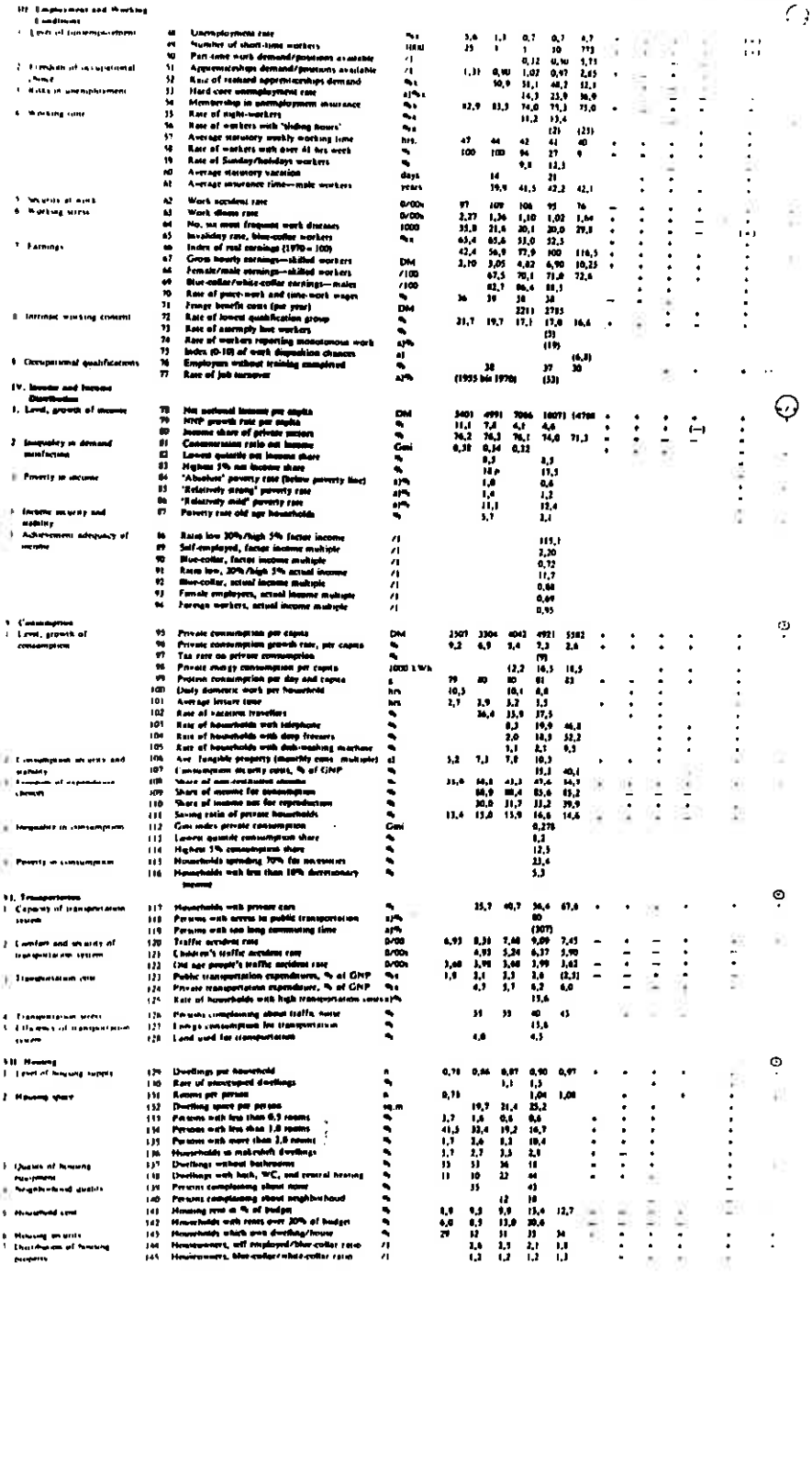


Figure [illegible] (continued)

VIII. Health								
1. State of health	146	Life expectancy at birth (males)	years	66,0	66,9	67,0	67,4	
	147	Life expectancy at 30 (males)	years	41,4	41,1	41,1	41,0	
	148	Life expectancy at 60 (males)	years	15,7	15,5	15,4	15,1	
	149	Days of disability, per person	days		22,3	20,9	20,3	20,6
	150	Days in hospital, per person	days		3,6	3,6	3,6	3,6
	151	Unemployables (disabled males, age 50-60)	%		9,7		9,0	9,0
	152	Mental health institutions, admission rate	%		0,13	0,12	0,17	0,19
	153	Health satisfaction index (range 1-3)	score			2,36	2,22	2,24
	154	Disability ratio blue-collar/white-collar	/1		3,0	3,1	3,3	
2. Health promotion	155	Persons without health insurance, rate	%		3,1	2,7	1,1	0,1
	156	Infant mortality rate	0/00	43,2	33,8	28,6	26,4	
	157	Health expenditures, in % of GNP	%			6,9	8,1	10,2
3. Health-related life conditions	158	Serious/deadly work accidents	0/00	6,1	3,6	3,1	2,9	2,6
	159	Serious/deadly traffic accidents	0/00	7,3	8,4	7,6	9,1	7,4
	160	Alcohol consumption per day	g	16,8	25,8	33,8	39,1	40,1
	161	Cigarettes consumption per day	av. no.	3,0	4,4	5,6	6,9	7,1
IX. Education								
1. Education attainment	162	Pre-school enrollment, ages 3-5	%a		33,4	32,7	38,4	54,0
	163	School-leavers (9th-graders without certificate)	%a		12,7	12,1	12,9	10,0
	164	Graduation rate ('Abitur,' 13th grade)	%a	3,7	5,7	7,5	9,6	13,6
	165	Completion rate (13th/7th-graders 7 years earlier)	/100		41,5	47,8	61,7	70,7
	166	University students rate	%a	1,6	2,5	3,0	4,0	7,5
	167	University applicants unable to get place of choice	a)					(80)
	168	University graduates/freshmen 5 years earlier	/100	77,2	69,8	55,1	71,9	83,3
	169	University students from working-class families	%	5,0	5,2	5,9	6,7	11,5
	170	Inscriptions for adult education classes	per 100	3,0	3,9	4,0	6,8	7,3
2. Qualification	171	Achievement test results (as yet no data)	a)					
	172	Persons reporting knowledge of foreign language	%		20	26	28	36
	173	Persons having completed vocational training	%				(50)	
	174	Persons with a foreman diploma ('Meister')	%				0,8	
	175	Technical college graduates ('Fachhochschule')	%				1,0	
	176	University graduates	%		2,2		2,4	
3. Efficiency	177	Unemployment rate, persons with no vocational training	%				(9)	
	178	Unemployment rate, university graduates	%				(1,3)	
4. Potential for innovation	179	Educational R&D expenditure/all educat. expendit.	%				0,1	
	180	Recurrent teachers educ. expend./all school expend	%				0,17	0,21
5. Ratio public/private educational sector	181	Secondary school students in public schools	%	89	88	88	90	
X. Participation								
1. Institutionalized political participation	182	Federal election turnout	%	88	88	87	87	91
	183	State election turnout	%	78	76	77	78	82
	184	Community election turnout	%	78	78	75	76	65
	185	Rate of registered party members	%			2,36	2,54	3,54
	186	Rate of citizen's movement members	%					(1,5)
	187	Persons reporting possibility of joining party	%	8	14	7	19	15
	188	Persons reporting poss. join. citizen's movements	%					(34)
	189	Persons reporting interest in politics	%		27	35	43	41
2. Participation in the economic/working domain	190	Trade union membership rate	%a	41,2	37,2	35,9	35,8	37,3
	191	Number of workshops with shop committees	1000			23,8	29,1	
3. Participation in other social domains	192	Social security committees election turnout	%a				20,5	41,[illegible]
	193	Registered church members	%		96		96	
	194	Regular church goers (once a month and more)	%			13		32
	195	Registered members of clubs/societies	%			12	31	50
4. Political confidence	196	Persons reporting satisfact. with political system	%				61	[illegible]

Source: Zapf (1980, p. 261-2[illegible])

Figure 1 INDIVIDUAL FACTORS AND SOURCES FOR CITY INDEX

[a/] Composite Ranks A = all 80 factors weighted equally, B = rank based on average of four major category ranks.

[b/] Subgroup Ranks C = based on 31 economic factors, D = based on 21 demographic and environmental factors, E = based on 8 crime factors, F = based on 20 recreation, education and other factors.

G, [c/] H, [d/] I, [e/] and [f/] See notes for individual factors.

Economic Factors

1. 1973 per capita income. Source: International City Management Association, *The Municipal Year Book 1976*. [g/] 1972 data.
2. 1973 per capita income CC/OCC: central city as percent of outside central city. Source: Advisory Commission on Intergovernmental Relations, *Trends in Metropolitan America*, February 1977. [g/] 1970 data calculated from *1972 City County Data Book*.
3. 1975 housing construction costs per square foot as percent of per capita income. Source: National Association of Home Builders, *Construction Cost Data Components*, June 1975. [g/] Cost of construction per square foot is for a nearby city.
4. 1975 hospital room costs as percent of per capita income. Source: Mutual of Omaha, "Semi Annual Health Care Cost Study," October 1976.
5. 1973 automobile and truck registrations per 1,000 population. Source: U.S. Department of Transportation, *Highway Statistics, 1973*. [g/] State average used. [h/] 1975 *Statistical Abstract*.
6. 1972 percent employees covered by bus transit (34 mile bands). Source: U.S. Department of Transportation, *1974 National Transportation Report, Urban Data Supplement*, May 1976. [g/] Add 13 percent coverage increase to Worcester SMSA. 1972 percent of population covered by bus transit (34 mile bands).
7. 1975 electric residential rates/1000 KWH as percent of per capita income. Source: Federal Power Commission, "All Electric Homes in the U.S.," January 1, 1975
8. 1975 electric commercial rates in dollars monthly/1000 KWH. Source: Federal Power Commission "Typical Electric Bills 1975."
9. 1975 electric industrial rates in dollars per 60,000 KWH. Source: Ibid.
10. 1976 natural gas rates for 1,000 cubic feet as percent of per capita income. Sources: U.S. Department of Commerce, *1972 Census of Manufactures*. [g/] State average.
11. 1963-1972 percent change in retail sales in the central city. Sources: Advisory Commission on Intergovernmental Relations, *Trends in Metropolitan America*, February 1977. [g/] Calculated from *1963 and 1972 Census of Retail Trade*.
12. 1963-1972 percentage point change in manufacturing employment (CC/SMSA). Source: Ibid. [g/] Calculated from *1972 Census of Manufactures*.
13. 1972 value added in manufacturing/wage paid. Source: Calculated from *1972 Census of Manufactures*.
14. 1972 value added in manufacturing/employees. Source: Ibid.
15. 1970 median house value (CC/OCC) in percent. Source: U.S. Department of Commerce, *1970 Census of Housing*.
16. 1975 building permits per 10,000 population. Source: U.S. Department of Commerce, Bureau of Census, *Construction Reports: Housing Authorized by Building Permits and Public Contracts, 1975 Summary*.
17. 1975 building permits (CC/OCC) in percent. Source: Ibid.
18. 1975 per capita bank deposits in thousand dollars. Source: FDIC, *Summary of Accounts and Deposits in all Commercial and Mutual Savings Banks, June 30, 1975*
19. 1975 average annual unemployment rate. Source: Employment and Training Report of the President, [g/] Rate of January 1976, from U.S. Department of Labor, Bureau of Labor Statistics, *Employment & Earnings*. [g/] *Colorado Employment Review*, Vol. XIII, No. 11, November 1976.
20. 1976 telephones per 100 population. Source: AT & T Long Lines, *The World Telephones 1974*. [g/] Estimated based on percent of housing with telephones from *1972 City County Data Book*.
21. 1974 per capita city debt as percent of per capita income. Source: U.S Department of Commerce, Bureau of Census, *City Government Finances 1974-75*
22. 1975 per capita municipal taxes as a percent of per capita income. Sources: Advisory Commission on Intergovernmental Relations, *Trends in Metropolitan America*, February 1977. [g/] Calculated from *City Government Finances in 1974-75*.
23. 1963-1972 annual percent change in assessed value of real property. Sources: Ibid [g/] Calculated from *1972 Census of Governments*, Vol. 2, Part 1, "Taxable and Other Property Values."
24. 1975 finance and general control government employees per 10,000 population. Source: U.S. Department of Commerce, Bureau of Census, *City Employment in 1975*
25. 1975 municipal bond rating. Source: International City Management Association, *The Municipal Year Book 1976*. Bond rating = AAA=1, AA+2, A=3, A=4 (AAA=1, AAA=2, AA+3 AA=4, CAA=9 CA=10 C=11).

Demographic/Environmental Factors

26. 1973 population density (persons/sq mi). Source: Advisory Commission on Intergovernmental Relations, *Trends in Metropolitan America*, February 1977. [g/] Population and commuting based on 1970 and 1973 city population in *Statistical Abstract 1976*. Area was calculated from U.S. Bureau of Census, *Boundary and Annexation Survey 1970-1975*
27. 1970-1975 net population migration in percent. Source: U.S. Department of Commerce, Bureau of Census, "Population Estimates," *Current Population Reports*, Series P-26, 1976. [g/] Estimated assuming births equal deaths.
28. 1960-1975 percentage point change in ratio of white population to total population. Sources: Advisory Commission on Intergovernmental Relations, *Trends in Metropolitan America*, February 1977. [g/] Calculation based on data from *1967 and 1972 City County Data Book*.
29. 1976 voters per 100,000 voting population. Source: *America Votes II, 1974*, Elections Research Center, 1975. [g/] 1973 votes. [h/] Estimated based on 1972 and 1974 votes.
30. 1972 divorces per 100,000 population. Source: U.S Department of Health, Education and Welfare, *Vital Statistics of the United States*, Vol III, 1972.
31. 1975 deaths per 100,000 population. Sources: U.S. Department of Health, Education and Welfare, *Reported Morbidity and Mortality in the United States, 1975*. [g/] Estimated based on data from *Vital Statistics of the United States*, Vol II, Part B, 1973
32. 1975 deaths from motor vehicle accidents per 100,000 population. Sources: Ibid. [g/] Estimated based on data from *Vital Statistics of the United States*, Vol II, Part B, 1973
33. 1973 [illegible] per 100,000 population. Source: U.S Department of Health, Education and Welfare, *Vital Statistics of the United States*, Vol II, Part B, 1973
34. 1975 [illegible] per 100,000 population. Source: U.S. Department of Health, Education and Welfare, *Reported Morbidity and Mortality in the United States, 1975*. [g/] Estimated based on data from *Vital Statistics of the United States*, Vol II, Part B, 1973
35. [illegible] Source: U.S Department of Health, Education and Welfare, *Vital Statistics of the United States*, Vol II, Part B, 1973
36. [illegible] Source: American Hospital Association, *Hospital Statistics, 1976*, Table [illegible]
37. [illegible] Source: Ibid
38. [illegible] Source: U.S. Department of Commerce, *1973 Statistical Abstract*.
39. [illegible] Source: American Hospital Association, *Hospital Statistics, 1976*
40. [illegible] Source: U.S. Department of Health, Education and Welfare, *Directory of Nursing Home Facilities* [illegible]
41. [illegible] Source: [illegible] Administration, *Limitations of Data* 1975 Annual Summary. [g/] Some of the smaller city [illegible] Statistical Abstract
42. [illegible] Source: [illegible] for Credit Data 1974 Annual [illegible] [g/] Average of [illegible]
43. [illegible] [illegible] [g/] Estimated based on [illegible] [illegible]

Figure 7 continued

INDIVIDUAL FACTORS AND SOURCES FOR CITY INDEX

[illegible] heating degree days. Source: National Oceanic and Atmospheric Administration, *Climatological Data, 1975 Annual Summary.* [1]Some of the [illegible]

[illegible] average wind speed (mph). Source: Ibid.

Crime Factors

[illegible] robberies per 100,000 population. Source: Federal Bureau of Investigation, *Uniform Crime Report*, 1975.

1975 negligent manslaughter per 100,000 population. Source: Federal Bureau of Investigation, *Uniform Crime Report*, 1975.

1975 non-negligent manslaughter per 100,000 population. Source: Federal Bureau of Investigation, *Uniform Crime Report*, 1975.

1975 rapes per 100,000 population. Source: Federal Bureau of Investigation, *Uniform Crime Report*, 1975.

1975 burglaries per 100,000 population. Source: Federal Bureau of Investigation, *Uniform Crime Report*, 1975.

1975 assaults per 100,000 population. Source: Federal Bureau of Investigation, *Uniform Crime Report*, 1975.

1975 larceny per 100,000 population. Source: Federal Bureau of Investigation, *Uniform Crime Report*, 1975.

1975 motor thefts per 100,000 population. Source: Federal Bureau of Investigation, *Uniform Crime Report*, 1975.

Recreation, Education and Other Factors

1976 scholars per 100,000 population. Source: *Directory of American Scholars*, Volumes I-4, R. R. Bowker Co., New York and London, 1974. [1]Estimated by Arbitron.

1975 library volumes per 100 population. Source: *American Directory of Libraries*, 1975.

1975 TV stations per 100,000 population. Source: *Broadcasting Yearbook, 1976*, Broadcasting Publications, Inc., 1976. [1]Chicago and Gary are in the same primary area, and

1975 radio stations per 100,000 population. Source: Ibid.

1975 hotel and motel rooms per 10,000 population. Source: *Official Hotel and Resort Guide*, January 1975. [1]From American Auto Association.

1972-1973 student/teacher ratio in public schools. Source: *Research Memo*, "Student-Staff Ratios, 1972-73," Educational Research Service, Inc., August 1974. [1]County or Parish-wide data. [2]U.S. Department of Health, Education and Welfare, *Directory of Public Elementary and Secondary Schools in Selected Districts*, Fall 1972. [3]Estimated using 1980 data.

1972 recreation and amusement establishments per 100,000 population. Source: U.S. Department of Commerce, Bureau of the Census, *1972 Census of Selected Service Industries*, SC(72)-1.

1972 eating and drinking establishments per 100,000 population. Source: U.S. Department of Commerce, Bureau of the Census, *1972 Census of Retail Trade*, RC(72)-1.

1974-1975 enrollments in higher education per 1,000 population. Source: National Center for Educational Statistics, *Education Directory, 1974-75*. [1]From City Association of Commerce.

1972 (percent of population covered by the transit CTA rate fund). Source: U.S. Department of Transportation, *1974 National Transportation Report Urban Data Supplement*, May 1976. [1]Estimate based on average of proximal and similar sized cities.

1974 air passengers per 1,000 population. Source: *Supplement to the Handbook of Airline Statistics*, 1974.

[illegible] circulation of daily newspapers as percent of households. Source: ABC Daily Newspaper Preliminary Figures as filed with the Audit Bureau of Circulations [illegible] six months ending September 30, 1976. [1]Supplement to ABC Newspaper FAS F & P, November 30, 1976.

[illegible] lawyers per 100,000 population. Source: *Martindale-Hubbell Law Directory*, Martindale-Hubbell Inc., 1975.

1976 contributions to United Way as percent of effective buying income. Source: United Way of America, *Measurements of Campaign Performance 1976*. [illegible] with value close to average value in the state.

1976 per capita form gifts for United Way in dollars. Source: Ibid.

1978 museums per 100,000 population. Sources: American Association of Museums, *The Official Museum Directory 1977*, National Register Publishing Co., Inc. [1]From City Chamber of Commerce.

1978 religious organizations per 100,000 population. Source: U.S. Department of Commerce, Bureau of Census, *1976 County Business Patterns*. [1]From 1975 County Business Patterns.

1975 park acreage per 10,000 population. Source: International City Managers Association, 1975 Unpublished Data. [1]From National Recreation and Park Association, *Recreation and Park Yearbook, 1976*. [2]From 1975 *Information Please Almanac*. [3]For the nearby city.

1975 golf courses per 100,000 population. Source: International City Managers Association, 1975 Unpublished Data. [1]From National Recreation and Park Association, *Recreation and Park Yearbook, 1976*. [2]From 1970, 1973 or 1976 *County Business Patterns*. [3]For the nearby city.

[illegible] swimming pools per 100,000 population. Source: International City Managers Association, 1975 Unpublished Data. [1]From National Recreation and Park Association, *Recreation and Park Yearbook, 1976*. [2]For the nearby city. [3]From city telephone directory. [4]From city Chamber of Commerce. [5]From City Recreation Department.

Figure 8 Criteria of social well-being and variables used in the Tampa study

Criteria and variables	Sign	r with I
I ECONOMIC STATUS		
Income		
1 Income per capita ($) of persons 14 and over 1970	+	1·00
2 Families with income less than $3,000 (%) 1970	−	0·60
3 Families with income over $10,000 (%) 1970	+	0·93
4 Persons in families below poverty level (%) 1970	−	0·61
Employment		
5 Unemployed persons (% total workforce) 1970	−	0·39
6 Persons aged 16–64 working less than 40 weeks (%) 1969	−	−0·35
7 White-collar workers (%) 1970	+	0·88
8 Blue-collar workers (%) 1970	−	0·54
Welfare		
9 Families on AFDC program (%) October 1971	−	0·43
10 Persons aged 65 and over on Old Age Assistance (%) October 1971	−	0·50
II ENVIRONMENT		
Housing		
11 Average value of owner-occupied units ($) 1970	+	0·88
12 Owner-occupied units valued less than $10,000 (%) 1970	−	0·56
13 Average monthly rental of rented units ($) 1970	+	0·76
14 Rented units with monthly rentals less than $60 (%) 1970	−	0·74
15 Units with complete plumbing facilities (%) 1970	+	0·53
16 Deteriorating and dilapidated houses (%) 1971	−	0·39
Streets and sewers		
17 Streets needing reconstruction (% of total length) 1971	−	0·27
18 Streets needing scarification and resurfacing (% of total length 1971	−	0·13
19 Sanitary sewer deficiencies (% of total area) 1971	−	0·01
20 Storm sewer deficiencies (% of total area) 1971	−	0·08
Air pollution		
21 Maximum monthly dustfall (tons sq mile) 1969	−	−0·09
22 Average suspended particulars 1969 (µgm m day) 1969	−	0·28
23 Maximum monthly sulfation 1969 (mg SO_3 100cm² day) 1969	−	−0·28
Open space		
24 Area lacking park and recreation facilities (%) 1971	−	0·09
III HEALTH		
General health		
25 Infant deaths per 1,000 live births 1970		0·19
26 Deaths [illegible] per 10,000 persons 65 or over) 1970	−	0·24
Specific health		
27 Cancer deaths per 100,000 population 1970		0·19
28 Stroke deaths per 100,000 population 1970		0·21
29 Heart disease deaths per 100,000 population 1970		0·17
30 New active tuberculosis cases per 10,000 population 1970		0·15

Criteria and variables	Sign	r with I
IV EDUCATION		
Duration		
31 Persons aged 18–24 with 4 or more years high school or college (%) 1970	+	0·62
32 Persons over 25 with 8 years or less school 1970	−	0·75
33 Persons over 25 with 4 years high school 1970	+	0·55
34 Persons over 25 with 4 years college 1970	+	0·85
V SOCIAL ORDER (OR DISORGANIZATION)		
Personal pathologies		
35 Narcotic violations arrests (per 10,000 residents 1971	−	0·22
36 Venereal disease cases (per 10,000 population 1970	−	0·48
Family breakdown		
37 Families with children, having husband and wife present: %, 1970	+	0·45
38 Persons separated or divorced %, ever married 1970	−	0·45
Overcrowding		
39 Dwellings with more than 1·0 person per room 1970	−	0·60
Public order and safety		
40 Criminal violation arrests (per 1,000 residents 1971	−	0·22
41 Juvenile delinquency arrests (per 10,000 residents 1971	−	0·32
42 Accidental deaths (per 100,000 population 1970	−	0·22
Delinquency		
43 Juvenile delinquency arrests by residence (per [illegible] population 1971		0·7
VI SOCIAL BELONGING (PARTICIPATION AND EQUALITY)		
Democratic participation		
44 Registered voters (% population 18 and over 1971	−	0·7
45 Eligible voters voting in general election 1971	−	0·[illegible]
Equality		
46 Racial distribution index 1970	−	0·[illegible]
47 Income distribution index 1970	−	0·[illegible]

Note A positive sign indicates high positive values are associated with high values and vice versa. In calculating the r values, the signs on all negative variables were reversed so that a positive correlation indicates a relationship in the direction anticipated by the sign of the variable in question.

Sources of data: see Smith (1973, 123-4), Smith and Gray (1972) and Knox (1982)

Figure 9 Indicators to examine socially disorganised areas in Barry, South Wales

SET 1: SOCIAL DEFECTS

Health defects

1. Percentage of the population with T.B. 1965.
2. Percentage distribution of T.B. cases.

The cases listed under variable 1 were assigned to their former addresses (if in the borough) where the condition was first diagnosed. The figures were then aggregated for each E.D. and expressed as a percentage of the total for the borough.

Financial problems

3. Percentage credit delinquents summoned, 1965.
4. Percentage recidivist rate delinquents (private tenants) summoned, 1959–64.
5. Percentage recidivist rent delinquents (municipal tenants) summoned, 1959–64.

Persons summoned (variable 4) not served with 'Notices to quit' on two or more occasions during the study period were defined as recidivists and included in the analysis.

6. Percentage distribution of recidivist rent delinquents. The cases listed under variable 5 were assigned to their former addresses (if in the borough). The figures were then aggregated for each E.D. and expressed as a percentage of total recidivists in the borough. Comparable data were not available for delinquents in the private housing sector (variable 4).

Criminal offences

7. Residence: adult offenders.
8. Residence: juvenile offenders.
9. Residence: offenders against the person.
10. Residence: offenders against property.
11. Commission: offences to persons.
12. Commission: offences to property.

Mean annual rates were calculated for variables 7–12 for the period 1960–64. Distinctions between the sexes were ignored, since the proportion of female offenders (2·8 per cent) was too small to warrant separate treatment.

Marital disorganization

13. Percentage persons divorced of ever married, 1961.

SET 2: OTHER INTRA-URBAN CHARACTERISTICS

Population structure

14. Percentage of population aged 0–14, 1961.
15. Percentage of population over retiring age, 1961.
16. Average age of the population, 1961.
17. Females per 1000 males, 1961.
18. Fertility ratio, 1961.
19. Percentage of the population 'foreign-born', 1961.

Mobility

20. Percentage distribution of L.A. tenants, 1965.

The tenants living in postwar municipal estates were assigned to their former addresses (if in the borough). The figures were then aggregated for each E.D. and expressed as a percentage of the total for the borough. Comparable data were not available for residents of the postwar private housing sector.

Accommodation and household composition

21. Percentage households with one person, 1961.
22. Percentage households with one or two persons, 1961.
23. Percentage households with five or more persons, 1961.
24. Percentage of dwellings, occupied or vacant, with 1–3 rooms, 1961.
25. Average number of persons per room, 1961.
26. Percentage households with over one person per room, 1961.

Figure 9 continued

27. Percentage households with over 1·5 persons per room, 1961.
28. Average number of persons per acre, 1961.

The area to which the density relates is the net area of each E.D., that is, residential area of E.D. ÷ resident population of E.D.

Housing characteristics

29. Percentage households living in shared dwellings, 1961.
30. Percentage households with shared use of kitchens, 1961.-
31. Percentage households with shared use of W.C., 1961.
32. Percentage dwellings in substandard condition, 1949–1965.

Very few dwellings in Barry are old enough and/or in a sufficiently advanced state of disrepair to warrant demolition. Many houses built before 1945, however, require major repairs or lack certain amenities (e.g. bath, shower, washhand basin, indoor W.C., hot water supply and a food store). Since 1949, several Housing Acts have empowered local authorities to make standard and discretionary grants for owners to make improvements to houses built before 1945. In addition the 1957 Housing Act enables private tenants to appeal to their local authority for a reduction in rents until their landlords make good certain improvements or major structural defects. The record of the combined distribution of these varied improvements constitutes the only accessible objective measure of dwellings which have been in a substandard condition at some time during the period 1949–65.

Household tenure

33. Mean gross rateable value 1961.
34. Percentage households owned by occupier, 1961.
35. Percentage households rented from Local Authority, 1961.

Age of housing

36. Local Authority dwellings built 1914–45.
37. Local authority dwellings built 1945–64.
38. Dwellings built before 1914.
39. Dwellings built 1914–45.
40. Dwellings built 1945–64.

The rates for variables 36–40 have been calculated as percentages of the total stock of houses in the Borough in 1964.

Land use

41. Commercial Industrial as percentage of total land use, 1961.
42. Institutional as percentage of total land use, 1961.
43. Public open space as percentage of total land use, 1961.
44. Residential as percentage of total land use, 1961.

Distance

45. Cost distance: Average single bus fare to C.B.D., 1961.
46. Distance to R.B.D.s, 1961.

Measurement of distance in ecological studies traditionally involves calculation from the original nucleus of the settlement, or the C.B.D. (often synonymous). Since Barry has 4 distinct regional centres, each E.D. has been assigned to its nearest R.B.D.

Physical traits

47. Average altitude.
48. Average amplitude of relief.

Economic Character

49. Occupied population as a percentage of total resident population aged fifteen or over, 1961.
50. Women as percentage of the total occupied population, 1961.
51. Unemployed as percentage of the economically active population, 1961.

Social class

52. Percentage of occupied and retired males in social classes 1 or 2, 1961.
53. Percentage of occupied and retired males in social classes 4 or 5, 1961.

The social classes consist of amalgamated socio-economic groups listed in the *Classification of Occupations, 1960*. Classes 1 and 2 are composed of groups 3 and 4; 1, 2 and 13: Classes 4 and 5 of groups 7, 10 and 15; 11, 16 and 17.

54. Percentage of households with private telephone, 1961.
55. Percentage of households with private car, 1961.

Education

56. Percentage persons with terminal education age over 15, 1961.

Figure 10 Illustrative community indicators

Illustrative Social Indicators

Problem	*Service*	*Indicator of Service Provision*
Pensioners living alone	Home helps	Hours of service per pensioner living alone
Lone parent families with children	Social Services financial aid	Expenditure per lone parent family or per large family
Large families with more than 4 children		
Married women working more than 30 hours with children under age 5	Pre-school playgroups	Places per 1000 children
Overcrowding	Housing	Number of households with more than 1 person per room per 1000 households

Illustrative Economic Indicators

Problem	*Service*	*Indicator of Service Provision*
Job Opportunity, Labour supply	Industrial promotion	Ratio of average gross male/female weekly earnings to the national average
Unemployment structure		Ratio of percentage of males/females earning under £40/£[illegible] 100 to the national average
[illegible]		Ratio of new industrial/covered warehouse/commercial office floorspace per 1000 population to the national average

Illustrative Environmental Indicators

Problem	*Service*	*Indicator of Service Provision*
Road congestion	Traffic management	Number of traffic wardens per 1000 registered vehicles
		Car parking spaces per 1000 registered vehicles
Housing stress	House improvement	Renovation grants per 100 houses lacking basic amenities
Dereliction	Land restoration	Area of land restored per 100 hectares of derelict land
Recreational opportunity	Swimming pools	Area of swimming pools per 1000 estimated participant population
Air pollution	Smoke control areas	Local areas with air pollution above acceptable standard (smoke/sulphur dioxide)

Source: CIPFA (1979, p.23, 36, 58)

Figure 11 EFFECTIVENESS MEASURES FOR RECREATION SERVICES

OVERALL OBJECTIVE. To provide for all citizens a variety of enjoyable leisure opportunities that are accessible, safe, physically attractive, and uncrowded.

OBJECTIVE	QUALITY CHARACTERISTIC	SPECIFIC MEASURE*	DATA COLLECTION PROCEDURE
ENJOYABLE NESS	Citizen satisfaction	1 Percentage of households rating neighborhood park and recreation opportunities as satisfactory	General citizen survey
	User satisfaction	2 Percentage of those households using community park or recreation facilities who rate them as satisfactory	General citizen survey or survey of users (of particular facilities)
	Usage—participation rates	3. Percentage of community households using (or not using) a community park or recreation facility at least once over a specific past period, such as three months. (For nonusers, provide the percentage not using facilities for various reasons, and distinguish reasons that can be at least partly controlled by the government from those that cannot.)	General citizen survey
	Usage—attendance	4 Number of visits at recreation sites	Attendance statistics estimates from general citizen survey
AVOIDANCE OF CROWDEDNESS	User satisfaction	5 Percentage of user households rating crowdedness of community facilities as unsatisfactory.	General citizen survey or survey of users (of particular facilities)
	Nonuser satisfaction	6. Percentage of nonuser households giving crowded conditions as a reason for nonuse of facilities.	General citizen survey
	Crowding factor	7. Average peak-hour attendance divided by capacity.	Attendance statistics and estimates of carrying capacity
PHYSICAL ATTRACTIVENESS	User satisfaction	8 Percentage of user households rating physical attractiveness as satisfactory.	General citizen survey or survey of users (of particular facilities)
	Nonuser satisfaction	9. Percentage of nonuser households giving lack of physical attractiveness as reason for nonuse	General citizen survey
	Facility cleanliness	10 Percentage of user households rating cleanliness as satisfactory	General citizen survey or survey of users
	Equipment condition	11 Percentage of user households rating condition of equipment as satisfactory	General citizen survey or survey of users
SAFETY	Injuries to participants resulting from accidents	12 Number of serious injuries (for example those requiring hospitalization) per 10,000 visits	Accident and attendance statistics
	Criminal incidents	13 Number of criminal incidents per 10 000 visits	Criminal incident statistics of some park and recreation agencies and most municipal police forces, attendance statistics
	User satisfaction	14 Percentage of user households rating safety of facilities as satisfactory	General citizen survey or survey of users
	Nonuser satisfaction	15 Percentage of nonuser households giving lack of safety as a reason for nonuse of municipal facilities	General citizen survey
ACCESSIBILITY	Physical accessibility	16 Percentage of citizens living within (or not within) 15 to 30 minutes travel time of a community park or recreation facility distinguished by type of facility and principal relevant mode of transportation.	Counts from mapping latest census tract population figures against location of facilities, with appropriate travel-time radius drawn around each facility
	Physical accessibility—user satisfaction	17 Percentage of user households rating physical accessibility as satisfactory	General citizen survey or survey of users
	Physical accessibility—nonuser satisfaction	18. Percentage of nonuser households giving poor physical accessibility as a reason for nonuse	General citizen survey
	Hours/days of operation—user satisfaction	19 Percentage of user households rating hours of operation as satisfactory.	General citizen survey or survey of users
	Hours/days of operation—nonuser satisfaction	20 Percentage of nonuser households giving unsatisfactory operating hours as a reason for nonuse	General citizen survey
VARIETY OF ACTIVITIES	User satisfaction	21 Percentage of user households rating the variety of program activities as satisfactory	General citizen survey or survey of users
	Nonuser satisfaction	22 Percentage of nonuser households giving lack of program variety as a reason for nonuse	General citizen survey
[illegible]	Staff helpfulness—user satisfaction	23 Percentage of user households rating helpfulness or attitude of staff as satisfactory	General citizen survey or survey of users
	Staff helpfulness—nonuser satisfaction	24 Percentage of nonuser households giving poor staff attitude as a reason for nonuse	General citizen survey

Source: Hatry et al (1977. p.42, 43)

Figure 12 Indicators of clinical activity in NHS

(1) Urgent, immediate or emergency inpatient admissions per 1000 population served.

(2) All inpatient admissions per 1000 population served

(3) Average length of stay

(4) 'Throughput' : average number of patients per head per year

(5) 'Turnover interval' : average length of time a bed lies empty between admissions

(6) Day cases as a percentage of deaths, discharges and day cases

(7) New outpatients referred per 1000 population served

(8) Ratio of returning outpatients to new outpatients

(9) Admission waiting lists per 1000 population served

(10) Estimated number of days taken to clear waiting lists at present level of activity

(11) Percentage of obstetric admissions that result in births (including stillbirths)

Source: Pollitt (1985, p.2)

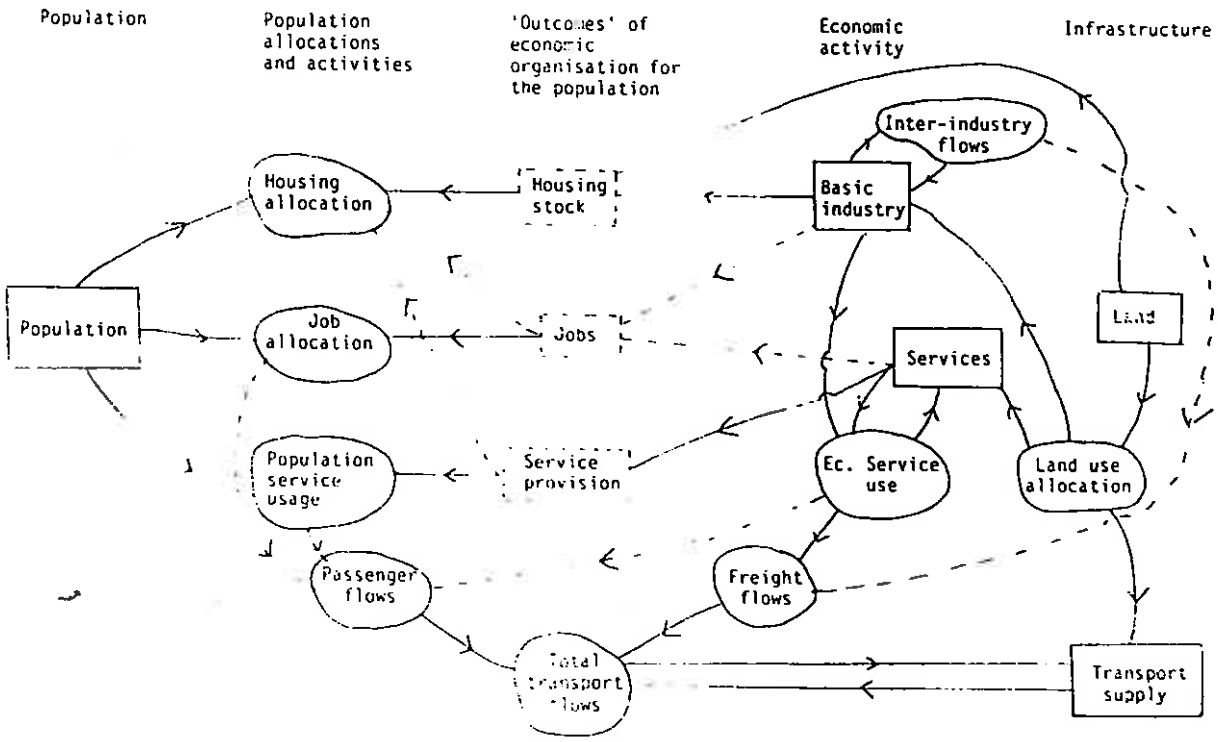
Figure 13 Illustrative 'subjective' indicators

Weights assigned to ten life-domains by 1450 survey respondents in Britain using an eleven-point scale (0 = completely unimportant, 10 = overwhelmingly important)

DOMAIN	*Mean Score*
The housing conditions you live in (number of rooms, state of repair, provision of running water, sanitary facilities, garage, garden)	8·5
Your neighbourhood and its environment (friendliness, cleanliness, appearance)	7·9
Your state of health (freedom from illnesses and the availability of medical services if you do feel ill)	9·1
Opportunities and facilities for education (being able to go to well-equipped schools, colleges, and so on)	7·6
Job satisfaction (how happy you are with the sort of work you do; how interesting it is)	8·1
Family life (being close to your family and relatives)	8·8
Your social status (what other people think of you; their respect for you in general; your standing in the local community)	6·1
Opportunities and facilities for leisure and recreation (things like parks, theatres, cinemas, sports centres, and so on; and having the time to make use of these things)	6·6
A stable and secure society (a society without a lot of crime, vandalism, and industrial strife, and one where you are taken care of if you are thrown out of work, or become ill, and when you retire)	8·5
Your financial situation (the sort of money you earn and the amount you are able to save if you want to)	7·9

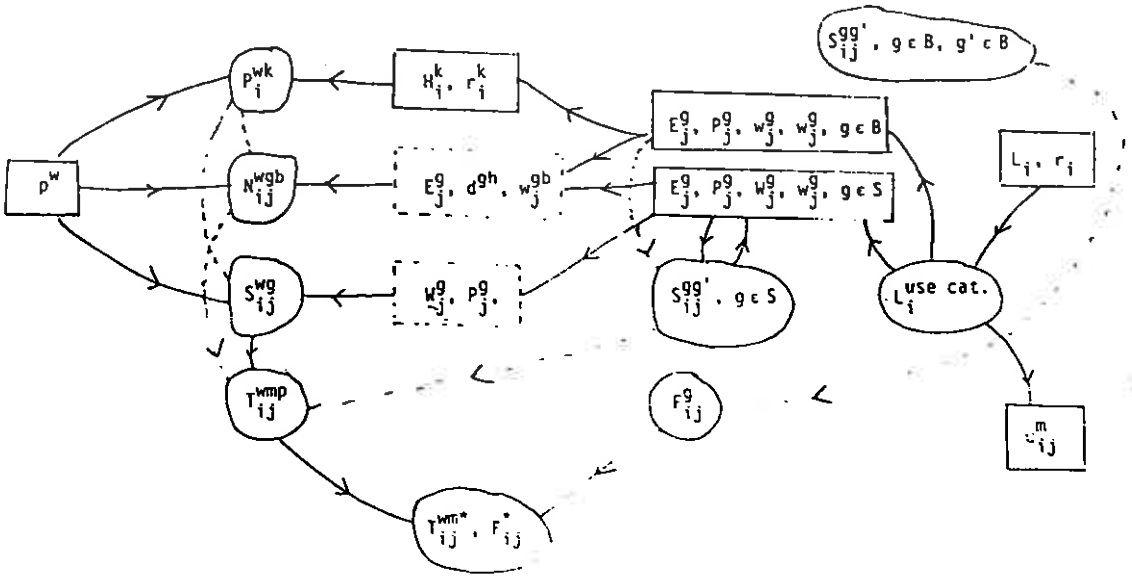
Source: Knox 1976, p. 16.

Figure 17 Principle of a comprehensive model



Source: Clarke and Wilson (1985b)

Figure 18 Typical variables in a comprehensive model



Source: Clarke and Wilson (1985b)

Key to Figure 18

H_i^k	:	houses by type k at i.
r_i^k	:	rents
L_i	:	land supply
r_i	:	land rent
$L_i^{\text{use cat.}}$	:	land at i by use cat.
p_i^w	:	w-type pop in i.
p_i^{wk}	:	ditto in house type k.
F_{ij}^g	:	flows of goods
N_{ij}^{wgb}	:	w-type p. res in i, wkg in sector g, in occ b in j
e_j^g	:	emp. in g in j
w_j^g	:	$\overset{\text{attr.}}{\text{size}}$ j of service sector
p_j^g	:	prices of goods
w_j^g	:	wage rates
w_j^{gb}	:	wage rates by occupation group
S_{ij}^{wg}, $S_{ij}^{gg'}$	:	service flows
T_{ij}^{wmp}	:	flows by mode and purpose

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