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Evaluation Methodology of Urban and Regional Plans: A Review

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LICHFIELD N. (1970) Evaluation methodology of urban and regional plans: A Review, *Reg. Studies* **4**, 151–165. Of recent years there has been advancement in the urban and regional planning process in terms of the conscious searching out of alternative policies, projects and plans with a view to selection amongst them of the preferred solution. The search may be confined to the design process of the professional planners culminating in one preferred solution to the political decision makers; or it may lead to the presentation of alternatives to the decision makers, with or without a recommendation as to choice. In both cases there is need for formal testing of the alternatives with a view to indicating the preferred choice. There has also been advancement in such testing methodologies. But a distinction is here made between tests in general and the particular test of a plan or project as a whole with a view to choice of that which is best in terms of community welfare. Such a test is here called Plan Evaluation.

After describing the generalities of tests the article makes a comparative review of some twenty plan evaluation methodologies which have been used in practice or advocated in the literature. It does so by reference to ten criteria to which comprehensive evaluation methodologies should conform if they are to suit the purpose, concerning itself with the potential of the methodology rather than the actual example of its use. It concludes in favour of the Planning Balance Sheet, that is cost–benefit analysis as applied to urban and regional planning, as having the greater potential.

Planning Decision making in planning Testing of plans Evaluation of plans Planning balance sheet Cost–benefit analysis Project appraisal Linear programming Goal achievement

THE PURPOSE of this article is to make a review of methods currently used or proposed for evaluation of both or either urban and regional plans. The aim of the review is to describe comparatively the broad range of methods available rather than offer a critique of their efficiency and value.

Evaluation here is the means of aiding the selection by the decision makers (those commissioning the plan) as to which of alternative plans they will adopt as the "best" for the community for whom they are planning; or aiding the planners themselves during the planning process in the similar need for selection, that is the rejection of alternatives that they do not intend to offer to the decision makers for adoption. *Evaluation* in this sense is one form of what is called the *testing* of plans or parts of plans, also with a view to selection as among alternatives. Thus testing and evaluation are linked in practice, and in the minds of planners. Accordingly the article starts with a review of what is normally meant by testing so that the contrast between testing and evaluation, and their respective places in the planning process, can be the more readily seen. But it is not the intention here that the linkage between the two be specifically brought out and for the contribution that testing in general could make to evaluation.

REVIEW OF PLAN TESTS

The simplest way of visualizing what is here meant by the testing (in the broad sense) of a plan or project is to imagine that somebody is intent on making a critical examination of it: for example, the planners themselves, the commis-

sioning body, a Ministry examining the plan of a local planning authority, an Inspector or Commission at a public hearing, other planners or a writer reviewing the plan for a journal. The review could take many forms. One simple form could be the listing of a series of critical questions (criteria) with a view to finding the answers which indicate whether the plan is satisfactory or not, on the criteria posed. Such questions might be: does the plan conform to acceptable planning standards (of open space, density, width of green belt) or planning principles (distribution of neighbourhood centres or segregation of pedestrians and vehicles) or has it been designed with acceptable technical skill (in highway or town centre lay-out)? Will the plan solution in fact cater for the current and future problems in the area under study? Will there be the economic resources and demand for the development envisaged? Are the relevant development agencies likely to be able to afford a particular project (LICHFIELD, 1964)?

While such tests will enable answers to be formulated to the questions on a particular plan they will also enable comparisons to be made between alternative plans for the same area, with a view to deciding which is the "best", and also possibly to permit of the generation of a plan which is "better" than those which have been put forward. In this context the "best" and "better" are chosen according to the pre-selected criterion, which can limit the degree of optimality of the final choice.

It is possible to carry out such tests when any particular plan or alternatives have been formulated by the planners for review in this way. However it is implicit in the planning process itself that the tests are carried out at appropriate stages during the plan preparation, so that plans which do not meet the tests are not proceeded with or, more generally, particular elements of the plan are accordingly re-designed. This will clearly apply to the selection of land for new development which will not fail on tests of physical suitability, or location in relation to other development, or inadequacy of public utilities without new major construction. It is by the application of such tests throughout the planning process that one or more solutions eventually evolve which are both feasible and also as optimal as the particular planning process allows.

Tests of this kind have always been germane to the planning process, even though certain plans of the past raise doubts as to whether such questions were seriously asked and answered. But although the testing process is an old one it is today being introduced at a more sophisticated level. The reasons are that a conscious search for alternatives plays a much greater part in the planning process today than before, as does the conscious presentation of alternatives to the decision makers for selection, such very presentation requiring a statement of the tests which have been introduced and the reasons why they have led to the alternative which is put forward for recommendation. But there is another reason, namely that the introduction of urban and regional models of various kinds enables more alternatives to be formulated and the alternatives to be tested by the use of computers, which both facilitates the introduction of the tests and also provides facilities for using them. These facilities have themselves enriched the planning process in making it possible to proceed to a particular solution on a "cyclical" rather than "linear" approach. In the latter there would be an attempt to generate the particular solution, in the somewhat step-by-step approach of the 1947 Act development plans which in brief envisaged the survey followed by the analysis followed by the plan and programme. An example of the former is seen in a recent sub-regional study (NOTTS–DERBY, 1969) where the plan finally put forward was evolved through four separate stages which moved from a broad review of a large number of possible strategies which were not precisely quantified to a small number of strategies which were very precisely delineated. The plan making process thus comprised four main cycles in each of which the sequence—formulation of concepts; translation into numerical and spatial form; testing; evaluation and conclusion—was followed. The conclusions from one cycle led directly to the plan formulation stage of the next cycle, and in this way the various alternatives considered at the beginning of Stage I were progressively reduced until the preferred strategy was put forward for testing in Stage IV. During these stages varying kinds of tests were carried out which led to the rejection of alternatives, tests such as the delimitation of areas having potential for development, the establishment of locations by modelling, a sieve map for eliminating areas unsuitable for development, testing of retailing locations by modelling.

This brief review of testing shows that the tests can be of varied kinds and used in varied ways. Further consideration of them is outside the scope of this article except in so far as some such tests are also used, as it will be seen, for the kind of evaluation which is of concern here.

But before leaving tests in the broad sense it is useful to attempt some categorization of them so that their link with the evaluation tests can be seen. A tentative categorization could be as follows:

1. *Internal consistency*

Do the varying quantitative elements in the plan (e.g. population, employment needs, employment opportunities, motor-car ownership, traffic flows, etc.) relate to each other in the statistical sense? This question can be applied to the total system dealt with by the plan or to part of the system, an example of the latter being the consistency between the traffic which will be generated by the land uses and the capacity of the traffic system to take such traffic, both in movement and when the vehicle is stationary.

2. *Locational suitability*

To what degree are the locations of the varying activities and functions appropriate in the sense that they are suitable to the activity (e.g. industrial location) and suitable to the people who will use them (e.g. residential location)?

3. *Conformity to standards and principles*

Are the elements in the plan appropriate from the viewpoint of standards and principles which are accepted in plans of the kind under consideration, such as acceptability being related to levels of performance?

4. *Problem solving*

Will the planning solution solve the problems of the area, both current and future, which have emerged from an analysis of the studies and forecasts in the planning process?

5. *Feasibility*

Are the planning proposals feasible, i.e. practicable, in regard to the various constraints which apply? These are several in character. Under economic feasibility will arise the question as to whether there will be the demand for the new accommodation of various kinds to be provided and also whether there will be available at acceptable prices the various factors necessary for the supply of the accommodation. Under financial feasibility comes a question of whether all the particular agencies who will be concerned with implementing the plan will find the relationship between revenues to be earned and cost to be incurred sufficient to attract their enterprise. Clearly differing rules will apply as between the private and public sectors; for the public sector there is question of whether the cost to be incurred can be matched by the revenues which will need to be raised, after allowing for grants, subsidies, etc. There then arises the question of administrative or organizational feasibility, for example whether the necessary statutory powers are available or the administrative organization to implement the plan. A final instance could be political feasibility; whether the proposals are acceptable to the people who will be affected, to their elected representatives and to the higher level or lower level political decision making bodies concerned.

6. *Design*

Having regard to all the preceding tests is the level of design, i.e. the level of creativity which has been introduced into the problem by the planners, of a good order, from the acceptable to the commendable?

7. *Flexibility and open-endedness*

Since the future is uncertain there must be provision in the plans for changing course if reviews after a few years show this to be necessary. Therefore some test needs to be made whether the planning proposals themselves are capable of such adjustment, in the light of what are shown by forecasts to be the main uncertainties.

From this categorization it is seen that these tests have as their general aim the production of plans which are technically competent and acceptable, and also generally practicable and feasible.

REVIEW AND CATEGORISATION OF PLAN EVALUATION METHODOLOGY

As just indicated, plan evaluation is a distinctive kind of plan testing. Its distinction lies in the fact that it is properly applied when the other tests have been met and also, as in all tests, in the questions which plan evaluation aims to answer. Put more simply (LICHFIELD, 1969), a town is a complex organism catering for the operational demands of all its inhabitants and users. Any proposals for its alteration or development will have advantages and disadvantages for every individual within it. A plan is intended to provide for all these operational demands, both current and prospective. While it is impossible to plan for optimum conditions for every current or future inhabitant or user, the plan proposals should aim to provide the best solution for as many requirements as possible, or the greatest aggregate net benefit for all concerned. Accordingly, any method of evaluation of alternative plans must be able to demonstrate how the operational demands of all the individuals concerned have been catered for (the benefits), and what consequential costs would fall on them.

It is in order to attempt an answer to these questions that the Planning Balance Sheet

methodology has been devised and applied in a series of case studies (starting with LICHFIELD, 1960). But other methods have been used, some attempting to answer different questions (e.g. STONE, 1963), some attempting the same question but using different methodologies (e.g. BEN-SHAHAR, *et al.*, 1969).

An earlier review of plan evaluation methodologies critically examined six, drawing attention to their limitations for the purpose in hand, and concluded "that in my view these widely ranging methodologies of plan evaluation fall short of the full needs of planning decision makers for evaluating plans in terms of what the community is asked to give up and what it would achieve" (LICHFIELD, 1968). In this article a more comprehensive review is made of the methodologies previously discussed and of others, but in a more systematic way. This is attempted by listing ten criteria which in my view a plan evaluation methodology should satisfy to discharge its full function, and by showing how the various methodologies, including the Planning Balance Sheet, fall short on these criteria.

The ten criteria are shown in Table 1. In brief the evaluation methodology should:

1. Have regard to the stated or implied objective (ends, values) of the decision makers (which may or may not be the objectives of those for whom they are planning).
2. Cover all systems of urban and regional facilities which are encompassed in the plan.
3. Cover all sectors of the community which are affected, that is which should be included within the decision maker's concern.
4. Sub-divide the sectors into producers/operators of the plan output and its consumers so that all the "transactions" implicit in the plan are considered.
5. Take account of all costs to all sectors, including externalities.
6. Take account of all benefits to sectors, including externalities.
7. Measure all the costs and benefits in money terms.
8. Facilitate the adoption of a satisfactory criterion for choice.
9. Show the incidence of the costs and benefits on all sectors of the community.
10. Be useable as an optimizing tool with a view to ensuring the best solution.

Each of the columns in Table 1 are sub-divided to show whether the methodology under review caters for the criterion in a partial (*P*) or full (*F*) sense. A × in the Table shows whether the treatment in this instance is partial or full but no attempt is made to distinguish between degrees of achievement (in which considerable variations exist). And a blank in the Table shows that the item is not considered at all, even by implication.

Coming now to the evaluation methodologies themselves it will be seen from the Table that eight distinct groups are attempted, these merely being convenient ways of dealing with groups of cognate methods which have originated from different sources. The groups start with the Planning Balance Sheet analysis, being the most comprehensive, with an indication of whether it partially or fully meets the ten criteria. From the Table it will be seen that it fulfils them fully on seven of the ten counts but only partially on three. This arises because it is recognized that all items cannot be measured in money terms with current measurement methodology (7) and applies itself to the questions of evaluation where some and perhaps many of the items of necessity are measured only in physical units, or are crudely ranked in order or are quite non-measurable. For this reason the full range of criteria of choice may not necessarily be available (8). And finally while the Planning Balance Sheet attempts to find the best solution among alternatives, and in this sense optimizes as far as possible, it is not inherently an optimizing analysis, as for example is linear programming (10).

This statement in relation to each of the criteria is then compared in the remainder of the Table with the other methodologies which are grouped under headings 2–8:

2. Checklist of Criteria
3. Investment Appraisal Financial
4. Investment Appraisal Economic
5. Goal Achievement
6. Cost Minimization
7. Cost Effectiveness
8. Cost–Benefit Analysis

We now proceed to each of these in turn, with sub-variants in each group, making 24 methods in all. Against each method is an indication of whether it has been used in practice on an actual problem or whether it is simply proposed in the literature. In the latter case some inference has necessarily been drawn as to the potential for the purpose of Table 1.

This wide ranging review probably means that in the space available some accuracy in description has been lost and some injustice done. But it is hoped that these are small.

1. *Planning Balance Sheet*

The reasoning behind the Planning Balance Sheet methodology for the purpose of plan

Table 1. Comparison of plan evaluation methodology by criteria*

Group No.	Description	Source	Theory practice		1 Objectives		2 Systems		3 Sectors		4 Producers Consumers		5 Costs		6 Benefits		7 Measured		8 Criterion		9 Incidence		10 Optimizing	
			T	P	P	F	P	F	P	F	P	F	P	F	P	F	P	F	P	F	P	F	P	F
1	*Planning Balance Sheet*	Lichfield (1960)		×		×		×		×		×		×		×	×		×			×	×	
2	*Checklist of criteria*																							
2.1	Advantages and disadvantages	Kitching (1963)		×	×			×	×				×						×				×	
2.2	Checklist of criteria	Kitching (1969)		×	×			×	×				×		×		×		×				×	
2.3	Checklist and costing	Llewelyn-Davies *et al.* (1970)		×	×			×	×				×		×		×		×				×	
3	*Investment appraisal—Financial*																							
3.1	Public development agencies	Lichfield and Wendt (1969), Wendt (1967)		×	×		×		×		×		×		×		×		×		×		×	
3.2	Public operating agencies	Mace (1961)			×		×		×		×		×		×		×		×		×		×	
3.3	All agencies—development and operating							×		×		×	×		×		×		×		×		×	
4	*Investment appraisal—Economic*																							
4.1	Highways			×	×		×		×		×		×		×		×		×					×
4.2	Municipal enterprise	I.M.T.A. (1969)		×	×		×		×		×		×		×		×		×		×		×	
4.3	Recreation	McCarthy and Dower (1967)		×			×		×		×		×		×		×		×		×		×	
5	*Goal achievement*																							
5.1	Bending on	Shankland Cox (1966)		×	×			×	×						×				×				×	
5.2	Policy evaluation matrix	Kreditor (1967)		×	×			×	×						×				×				×	
5.3	Goals achievement matrix	Hill (1967)	×			×		×		×			×		×		×		×			×		×
5.4	Objective fulfilment analysis	Schlager (1968)	×			×	×						×		×		×		×				×	
6	*Cost minimization*																							
6.1	Costs in use	Stone (1967)		×	×			×		×	×						×		×		×		×	
6.2	Threshold theory	Kozlowski and Hughes (1967)		×	×		×		×		×		×				×		×		×		×	
7	*Cost effectiveness*																							
7.1	Planning, programming and budgeting		×		×			×		×					×		×		×		×		×	
8	*Cost–benefit analysis*																							
8.1	Warsaw optimization planning	Planning Research Unit (1970)	×		×		×		×				×		×		×		×		×		×	
8.2	Linear programming	Ben-Shahar (1969)		×	×		×		×				×		×		×		×					×
8.3	Maximize land values	Lean and Goodall (1966)	×	×		×		×					×		×		×		×				×	
8.4	Cost–benefit analysis:																							
8.4.1	Rothenberg (1967)			×	×		×		×				×		×		×		×				×	
8.4.2	Mao (1966)			×	×		×		×				×		×		×		×				×	
8.4.3	Commission on T.L.A. (1970)			×				×		×				×		×		×		×	×		×	

* By "plan" here is meant either a project or a complete plan.

evaluation has been described elsewhere (LICHFIELD, 1960 and LICHFIELD, 1964), and also the application to case studies, demonstrating its potential (LICHFIELD and CHAPMAN, 1968) and also the research needs for its greater maturity (LICHFIELD, 1964). Thus it is thought necessary for this review only to restate the approach in simple terms. "To evaluate alternatives from the point of view of every individual concerned would be a virtual impossibility. Therefore, the planning balance sheet groups the community into various homogeneous sectors distinguished by the kind of operations they wish to perform. It then evaluates and compares the alternatives from the point of view of the advantages (benefits) and disadvantages (costs) accruing to every sector from each alternative, to see which would provide the maximum net advantage (benefit). Since the analysis is being made in respect of urban and regional plans, it must include all features of relevance in such plans. It follows that as well as those benefits and costs which are measurable in money terms, there are others that are only measurable in some other unit (time, physical) and others that are non-measurable. Thus, the balance sheet cannot, and does not, aim to provide a conclusion in terms of rate of return or net profit measured by money values as is the case in some typical cost–benefit studies. Its value lies in exposing the implications of each set of proposals to the whole community and to the various groups within that community, and also in indicating how the alternatives might be improved or amalgamated to produce a better result. The purpose of the approach is the selection of a plan which, on the information available, is likely to best serve the total interests of the community" (LICHFIELD, 1969).

2. *Checklist of criteria*

The second group deals with methodologies developed amongst physical planners.

2.1. *Enumeration of advantages and disadvantages.* KITCHING (1963) demonstrates this method in relation to alternative possible plans for Greater London. He takes as a starting point the expected population increase of two to four million in South-East England between 1963 and 1981 and suggests five possible basic patterns which could be followed for its accommodation. These are briefly: unrestricted growth of London, following present pattern of development plans, concentration of growth into one new city, six to twelve new cities or linear towns stretching radially from London. From the "balance sheet" of advantages and disadvantages Kitching draws conclusions on each and then puts forward a composite pattern which in his view would be the most satisfactory. In relation to the criteria of Table 1, it will be seen that the aim is to consider all the systems concerned in the plan but there is only implied reference to objectives, sectors of the community, costs and benefits. The criterion is limited (the greatest net advantage). The method is only partially optimizing, in the trial and error sense. There is no attempt to distinguish between the producers/consumers, nor is the incidence of the advantages and disadvantages brought out. Nor is there any attempt at measurement, so that the comparison is entirely subjective to the analyst.

2.2. *Checklist of criteria.* KITCHING (1969) has also demonstrated this approach in relation to the regional planning considerations affecting the four sites selected by the Roskill Commission for the Third London Airport. He first enumerates seven characteristics which one would ideally seek in siting a major international airport in the South-East Region: communications, airport noise, growth potential of population and industry, labour costs, amenity and agriculture and services. He then examines each of the four possible sites in relation to each of these criteria, using such data as are available and forms a judgement as to the order of choice in relation to each. These are set out in a summary table with the sites ranked 1–4 for each, 1 being the best and 4 the worst. From this table of crude, that is unweighted, ranking he draws conclusions. In relation to the criteria in Table 1, the method is much the same as that of "advantages and disadvantages", except that there is a certain degree of measurement introduced, by ordinal ranking. As to optimizing, there has been no attempt to find a better site than the best of the four, since this was not the point at issue, but inherently the method could be used for this purpose.

A combination of the methods in 2.1 and 2.2 appears in a study analysing four alternatives for the designated area of a new town in Lancashire (MATHEW *et al.*, 1967). After studying the theoretical basis of urban form the study established a list of nine criteria as a sieve through which the various options for development were assessed. Ten possible options were thus reduced to three which were then developed in greater detail and reassessed against the nine criteria by listing each one's advantages and disadvantages from which the preferred option, modified slightly, emerged.

2.3. *Checklist of criteria and costing.* An improvement on the methods in 2.1 and 2.2 was developed by Consultants appointed by the Roskill Commission to find suitable locations for the associated urban development of each of the four

alternative airport sites, following a comparison of alternatives (LLEWELYN-DAVIES *et al.*, 1970). The process of comparison and selection was agreed with the Commission and was basically the same for all four sites. The approach was as follows.

Firstly, certain elements in the development were costed (construction of site development, engineering, transportation, provision of major services and shopping centres, land acquisition, losses in agricultural output, user transportation costs) and then there were listed a large number of criteria on which schemes were not costed. These criteria were applied to the alternative strategies in two stages. At the first stage the strategies (including those which had been costed) were roughly ranked on a five-point scale in respect of each criterion without costing. Pairs of strategies were then compared and when one dominated (that is had an inferior ranking for at least one criterion and no lower rankings) it was rejected, so reducing the number of alternatives. At the second stage the costed items were introduced, the alternative with the lowest total cost being provisionally selected. The uncosted criteria were then examined to establish whether there were any factors that might outweigh the least cost. This was the final judgement leading to a selection of the preferred strategy.

From the criteria in Table 1 it is seen that although the amount of scrutiny and costing is greater than in the two previous methods, and is thus more likely to lead to a better selection, inherently the method is a more sophisticated attempt at the checklist of criteria of 2.2. But it does introduce the important feature of offsetting measured money costs against features which cannot be costed as a basis for judgement.

3. *Investment appraisal—Financial*

The next group of evaluation methods stems from the quite different source of those concerned with the financial appraisal of investment, that is financial costs and returns which will flow to the particular decision maker who is considering alternative investment possibilities. The source here comes jointly from economics, accountancy and real estate valuation (LICHFIELD, 1956; LICHFIELD, 1967). The feature of the method is that only the financial costs and returns directly of interest to the investing or decision making body are of interest, and not the inevitable external repercussions affecting others.

3.1. *Public development agencies.* Although not intended as an evaluation exercise, LICHFIELD and WENDT (1969) demonstrated in their analysis of the financial experience and expectations of six English new towns the manner in which the analysis could be used for evaluation. After introducing the cost elements for the new towns as a whole, including all agencies, they concentrated on the experience of the New Town Development Corporation, both as regards the financial costs which fell upon them and the financial returns they would obtain. Writing in 1962, they reviewed the experience to 1961 and then made forecasts on a comparable basis to the expected dates on the completion of the towns. On the costs side came all investment and on the revenue side came all rents, after deducting real estate operating expenditures.

The interest in this particular study was the costs and returns at the dates mentioned, which were of relevance. But investment appraisal as such would necessarily include discounting of the expected streams of costs and returns to the date of decision. WENDT (1967) has applied such a model to private enterprise real estate development in the United States.

In Table 1 the method is related to the criteria irrespective of whether discounting is or is not applied. From the Table it will be seen that only part of the objectives, systems and sectors are examined, and only part of the costs and benefits and therefore incidence. There is a clear distinction between producers and consumers, all relevant costs and returns are measured, thus providing full opportunity for the use of the relevant criteria, but the range of costs and benefits and of criteria are still partial in the planning sense. The model is an optimizing one, as adapted for computer use (WENDT, 1967), but again is only partial for planning purposes.

3.2. *Public operating agencies.* Coming from quite a different source are the appraisals of costs and returns to public operating agencies, notably local authorities concerned with developments affecting their municipality. These are known in this country in the everyday exercises of municipal treasurers for their short-term or long-term budgets. An early example for planning was found in the Development Plan for Middlesbrough (County Borough of Middlesbrough, 1951). But the methodology is much more developed in the United States under the general heading of cost revenue analysis. MACE (1961) gives a full review of their relevant studies in the U.S.A. Here again the emphasis is mainly on the particular public sector of the local authority, and of main interest is their financial investment and operating costs on the one hand and their revenues from the tax base so created on the other. From this it follows that the suitability of the analysis of planning methodology is similar to that in 3.1, the difference between the two

being the concern with investment in the first and with development and operation in the second.

3.3. *All agencies—development and operating.* With the growing number of new towns and large-scale urban renewal plans of recent years there has also been growing the tendency for full-scale financial appraisal of the alternatives. Many examples exist of cost estimates of construction (e.g. WELLS, 1963 and BUCHANAN, 1967). Some also have attempted the total stream of costs and revenues from development falling on all agencies (LICHFIELD, 1967, 1968). Lichfield and Associates (1969) have also presented an analysis for the financial implications of alternative urban renewal projects having regard to all sectors of the community who would be affected as producers and consumers.

However there still remains to be attempted the comprehensive financial analysis which will have regard not only to all agencies but to both initial and continuing costs and returns. If this were done it would meet the criteria of Table 1 in the manner shown. Firstly it would cover all systems and sectors (in contrast to methods 3.1 and 3.2) but in all other respects would be the same as those two methods. Secondly to some degree it would take account of externalities, in the sense that concurrent estimates for all agencies would avoid having regard to costs or returns without compensating adjustments on other sectors. But the coverage would still not be full in the planning sense; since the costs and returns would relate only to the financial flows there would not be considered those costs and benefits to which money does not pass (for example, time spent in travel, effect of noise, injury to landscape views).

4. *Investment appraisal—Economic*

The next group comes from the distinct source of economists applying cost–benefit analysis techniques to particular public sector investments following the initiation of such attempts by engineers. While the theory goes back further (KRUTILLA and ECKSTEIN, 1958) modern attempts started with application in the United States to water resource and highway projects and since then the application has ramified throughout the whole of the public sector, with economists attempting to find some economic rationale for public sector investment projects, such as health, education and defence. PREST and TURVEY (1966) give a wide-ranging review of both the literature and the application. If a common feature is to be sought on the application it is in the isolation of the particular system under examination from the remainder of systems, the measurement of costs and benefits relating to that system with regard only to externalities affecting that system. Accordingly it is necessary to consider only one form or facility as an example, and highways are chosen since they are of great relevance in planning and highway cost–benefit analysis has advanced considerably.

4.1. *Highway.* Highway cost–benefit analysis methodology has been greatly advanced since the pioneering work in the United States. More recent examples of the analysis in this country are in the London Transportation Study (GREATER LONDON COUNCIL, 1969) and in THOMPSON (1969). From what has been said above it is apparent that since only part of the urban system is being analysed there is only partial reference in the planning sense to most of the criteria referred to in Table 1. An implicit distinction is made between producers and consumers. But there is considerable advancement in relation to optimizing. With the great development in urban transportation models and the use of computers it is possible for the analysis of costs and benefits to be used to optimize the system, as a whole taking account of marginal changes on the whole network.

4.2. *Municipal project.* A recent most interesting development has come from the marriage of those concerned with municipal finances who have previously worked under group 3.2 above but have seen the need to widen their analysis in the direction of cost–benefit. The result has been the generation of a series of wide-ranging case studies covering many aspects of municipal work, from alternative means of expanding a town to the question of whether refuse containers at houses should be in dustbins or paper sacks (I.M.T.A., 1969). The approach has extended towards the planning balance sheet analysis but otherwise the studies have contributed little towards the development of the technique in relation to municipal projects and are accordingly so shown in Table 1, except for optimizing since the analysis is not always applicable to computers.

4.3. *Recreation.* Although coming within the same area of endeavour as item 4.2 special mention should be made of a pioneer attempt in recreation planning since it was initiated from another source, by physical planners (MCCARTHY and DOWER, 1967). This essay is notable for its placing of the technique within a comprehensible decision making process and also for the attempt to measure the capacity of natural resources for use by holiday makers, tourists, visitors, etc. From this capacity is generated the benefits which the use of the facility will generate. These are then compared with the cost of providing the facilities. This leads to a planning budgeting

process, which measures the investment required in financial terms. However while the approach could be applied more extensively it is nonetheless only partial in terms of Table 1 and is shown in a manner similar to municipal project appraisals in item 4.2.

5. *Goal achievement*

The next group of evaluation tests have derived from varying sources but have in common a simple approach: to what extent will the plan as designed meet objectives which have been set in advance. In general it is these objectives which are the benefits to be derived and it is the likely success or failure in doing (as opposed to the costs involved) on which the plans are compared. But in each case the approach is somewhat different, thus needing separate treatment.

5.1. *Bending on.* This popular term is applied to a process used in Britain which in essence attempts to find the ideal urban or regional form and then tests alternative plans as to whether or not they approximate to the form. An example in relation to the expansion of Ipswich will illustrate (SHANKLAND, COX and ASSOCIATES, 1966) although others exist (BUCHANAN, 1967). This formulated some social and economic objectives in general terms and then tested them (by simple ranking) against alternative diagrammatic ideal urban forms for the expansion of the town. The ranking led to a preferred alternative which was then developed in detail as the solution, by bending on to the site in question, having regard to the opportunities and constraints on the ground.

There is therefore only a tenuous link between objectives and the ideal urban form and there is no certainty that the bent-on variation from the ideal is better or worse in a particular situation than a bent-on version of another diagrammatic form that has been rejected. Furthermore there is no attention to the costs of achieving the benefits that are so derived. The outcome is shown in Table 1 according to the criteria. While the attempt is made to consider all systems there is no attempt to cover all sectors in the analysis. Producers and consumers are not distinguished and nor are the costs falling on them. There is partial attention to benefits in terms of objectives but these are not measured, so that only a partial criterion is available with little reference to incidence. To some degree the attempt is an optimizing one in the sense that it is the ideal form which is sought by design before the process is started.

5.2. *Policy evaluation matrix.* KREDITOR (1967) compares more directly the objectives for the actual plan proposals. He sets up a matrix whereby alternative plan proposals are ranked against a series of objectives to show whether each is affected directly, marginally, negatively or not at all, by each hypothesis. The result is a visual ranking in these terms from which the preferred solution is selected for study. This approach is useful in linking objective and end product but is not comprehensive as to objectives, would not for example show the distinction between cost (input) and benefit (output) nor indicate the marginal differences in such costs and benefits which are necessary to show the best scheme. And there is no attention to incidence. From this it follows that much the same position is recorded on Table 1 as item 5.1, although there is less conscious search for the optimal.

5.3. *Goals achievement matrix.* HILL (1967, 1968) has developed the goal achievement approach, under the title of goals achievement matrix, to a more sophisticated level. Essentially it is the same approach as in item 5.2, but there is considerable improvement in that the whole issue of objectives is more carefully considered, the analysis is by sectors and objections are preweighted in the analysis so that the decision makers are faced with results in terms of prior weighted preferences as to these matters. These differences are reflected in Table 1. This method in its potential is the nearest in comprehensiveness to the Planning Balance Sheet, but by comparison with that method is less developed in terms of costs and benefits and measurement.

A characteristic of this method is that both costs and benefits are always defined in terms of goal achievement. Thus benefits represent progress towards desired objectives while costs represent retrogression from desired objectives. Each objective thus has its characteristic set of costs and benefits measured in the same terms as the objectives. The preferred outcome is determined on the basis of a goals-achievement account, by weighted indices of goals-achievement or by means of goals-achievement transformation function. The goals-achievements account is similar in form to the outcome of the planning balance sheet. Weighted indices of goal achievement can lead to single unequivocal outcomes but are greatly dependent on the validity of the weighting and the measurement scales employed. Goals-achievement transformation functions are theoretically promising but would be very difficult to apply in practice. The approach lends itself to incorporation in programming techniques. One such approach (HILL and SHECHTER, 1970) employing weighted indices of goals achievement in a zero-one Boolean programming model is applied to the

planning of outdoor recreation facilities. Objectives considered include national and regional economic benefits, equity, choice, participation and nature preservation.

5.4. *Objective fulfilment analysis.* An extension of the approach by Hill is given by SCHLAGER (1968). The extension relates in even greater differentiation between the fulfilment of the objective. "In each case, the objectives already defined were grouped into three major categories. These categories of objectives were ranked in order of their increasing importance. Then the three alternative plans were ranked on each category of objective in order of their increasing ability to meet each category . . . These weighted scores were summed for each alternative achieving an overall score for each plan. Finally, this score was weighted by a 'probability of implementation' subjectively reflecting the difficulty of implementing the plan. The alternative with the highest weighted score was considered to be the preferred alternative." From this description it will be seen why the method is described as "rank-based expected value". Features of the system are shown in Table 1. It corresponds with item 5.3 except that there would appear to be less emphasis on sector and incidence. But the criterion elements is strengthened through the introduction of the ranking for probability of implementation.

6. *Cost minimization*

The next group relates to attempts from a differing source to evaluate alternatives in terms of the input costs, the criterion being one of cost minimization.

6.1. *Costs in use.* STONE (1963, 1968) has developed methods for estimating private and public capital and operating costs in town development for "comparing alternative means broadly to the same ends, any differences in the end product being regarded as imponderables to be assessed against the costs differences". For such costs he has used the phrase "costs in use" which relate to average per capita costs of the whole plan or its phases. Stone has applied the technique to theoretical urban forms of different sizes. The method has direct links with the group of methods under 3 above, financial investment appraisal, except that a feature of the analysis is to distinguish also between resource and financial costs. The conclusions for plan evaluation are drawn in Table 1. In terms of systems and sectors the attempt is to be comprehensive, but the formulation of objectives is very limited, being related only to cost; as to costs little regard is paid to externalities and benefits are ignored. Within the limitations described the measurement is full in money terms but the criterion and incidence are also limited. As with other methods it can be used on a trial and error basis for optimization.

6.2. *Threshold theory.* The theory and application which is becoming widely known under the title "threshold" has quite different origins, stemming in the main from physical planning and also from Poland (MALISZ, 1966; KOZLOWSKI, 1968; KOZLOWSKI and HUGHES, 1967; HUGHES and KOZLOWSKI, 1968). In essence it is the application to plan design of simple rules in economics, namely that investment gives rise to both fixed or overhead costs and also variable or operating costs. Whereas the costs per unit of supply must decline in relation to overhead costs, it can follow different curves in relation to operating costs. The aim is to find that degree of investment in which the combination of overhead and operating costs are at a minimum. The search for these points recognizes that the threshold (the points of minimum cost of investment) can be divided threefold into physical constraints (topographic and land resource costs), quantitative constraints (limiting capacities of existing public utilities), and structural constraints (limitations of existing urban development). While the method can be used for cost minimization in certain systems and sectors it is essentially an optimizing and design tool for searching out those thresholds which will produce cost minima.

The features are shown in Table 1. As indicated the objectives are limited and the coverage is only for part of the system and accordingly only some of the sectors. There is regard only to the costs of production and normally no regard to benefits. Within these limitations, the measurement, criterion and incidence are partial and while the method aims at optimizing as regards minimal cost, since there is regard only to cost minimization it cannot be called an optimizing method in the full sense.

7. *Cost effectiveness*

Whereas in cost minimization it is the end product which is assumed to be constant so that the aim is the minimization of cost, in cost effectiveness the reverse is applied. Here it is the cost which is assumed to be constant and it is the effectiveness of using such cost (in different situations) which is compared. The origins of this approach are in systems analysis which was initially applied to problems of defence in the United States (HITCH and MCKEAN, 1960) and since 1965 has been attempted for civilian departments in the United States and more recently in this country (NOVICK, 1967).

7.1. *Planning, programming and budgeting.* It is

under this title that the application has been developed to civilian expenditures. Essentially the need is to be able to measure the outputs from particular expenditures. However, since by definition the outputs are rarely transacted in the market, the problem becomes one of measurement of public goods and intangibles. The search for such measurement has been pursued not only in typical cost–benefit studies but also as social as opposed to economic indicators (BAUER, 1966). Inherently therefore the approach is usable for urban and regional plans but to date there has been no formal application. However from the theory and literature it is possible to visualize the nature of the application to plan evaluation and this is suggested in Table 1. In essence we have a similar scoring as for costs in use, the method simply being the reverse side of the coin, where benefits are explored rather than costs. But P.P.B. is very strong on the formulation of objectives, which are an essential feature of measurement of output; and by the same token weak on measurement itself because of the difficulties mentioned above. However there is no reason why costs should also not be introduced, where these are variables. In the Planning Balance Sheet literature this becomes known as cost utility analysis and as such is indistinguishable from cost–benefit analysis, to which we now turn.

8. *Cost–benefit analysis*

Not all the evaluation methods included under this head can be called cost–benefit analysis, for this has somewhat a rigorous economic connotation. However there are other methods which recognize both the cost and benefit side of the evaluation problem, and for that reason are mentioned here, and first:

8.1. *Warsaw optimization planning.* Under this head are described the developments of threshold theory in Poland, where the attempt is not simply to minimize investment costs but also concurrently to maximize the effects which are outputs from the investment. Although already applied by Polish planners on a limited scale, to residential functions only, in the plans for Warsaw and Skopje, the method is still in the research stage in this country. As with the threshold analysis it is a practical planning tool for searching out solutions, hopefully optimal ones, and thus lends itself to evaluation in the same terms. Briefly, it is visualized that the first phase of the process is to search out the costs of developing the land in question, the second is to search out the best way of using the land and in the third phase to combine the two sets of findings by means of a computer programme. Just how the method would work over a comprehensive plan has been suggested (PLANNING RESEARCH UNIT, 1970). For the purpose of Table 1 all that would appear to be claimed is for a partial treatment of systems and sectors, and also costs, benefits, criteria and incidence. But if the research were successful it might well be that the method would be an optimizing tool, in at least a partial sense.

8.2. *Linear programming.* Linear programming is an operational research technique permitting the optimization of an objective function which is subject to a number of well-defined linear inequality constraints (DUCKWORTH, 1965). As such the technique has had wide application (DORFMAN *et al.*, 1958) and since the early 1960s has been applied in land-use allocation models (HARRIS, 1965). More recently it has been developed in Israel as a means of finding optimal solutions to planning problems, the aim being to use it for most types of plans (BEN-SHAHAR *et al.*, 1969). The authors recognize that "the purpose of the town planners is to make a feasible plan which conforms with the existing constraints and maximises the value of an accepted social welfare function as well". They recognize that the list of constraints is very long, that some can be translated into money values and others not. The items which can be translated into money values are expressed in the objective function and those which cannot are expressed as constraints. These are expressed in linear programming form, so that the computer searches out all possible alternatives and determines "simultaneously the quantity of every component of the efficient programme, that is the programme in which the present value of the welfare function is maximised", subject of course to the constraints. The method can also produce useful by-products, such as the shadow price of the constraints (which might have been subjectively determined) and also the marginal output on the land.

The strength of this approach is clearly its ability to search out the preferred of a large range of alternatives, to optimize simultaneously and to generate shadow prices for marginal elements of constraints. As such it is the most powerful of the optimizing models. However the limitations must rest with the limitations of linear programming as such, namely that the objective function is most difficult of specification, the relationships of the function and constraints are not simply linear and the definition of the constraints cannot always be simply made in mathematical form. Thus it has been argued that linear programming "can be useful if used for exploration to suggest possibilities;

but also it ignores so much, and simplifies so much, that it should probably never be used in any more exalted way" (PARRY-LEWIS, 1970). Thus the technique can only solve problems for which it is suited. This the authors recognize, and suggest that such problems will be solvable with the use of non-linear techniques, such as quadratic programming, whereby certain non-linear aspects such as economies of scale and differential weights in the concentration of urban centres can be dealt with (BEN-SHAHAR *et al.*, 1969).

On the basis that linear programming can only do what the programme permits it to do, then its contribution to plan evaluation is shown in Table 1. Clearly it is a method of partial analysis throughout, because it does not throw up the differences between producers and consumers nor does it show incidence. However it is very strong as an optimizing tool.

8.3. *Maximize land values.* The difficulties in the linear programming model of finding the correct objective function are treated very lightly in the suggestion that such a single index of social welfare can be found in aggregate land values. LEAN and GOODALL (1966) state: "if it is calculated that town planning will lead to higher land values than would exist without it, then it is desirable from an economic point of view. The town plan that would lead to the highest aggregate land values is the best economically." The simple basis for the approach is derived from rent theory, that the greater the aggregate land values (capital returns minus capital costs of construction) the greater overall benefit to the community to be derived from the plan.

This would be an attractively simple index. But there are difficulties. Lean admits that the theoretical difficulty of placing money values on non-revenue-producing public sector development, a large part of any town, is insuperable. Furthermore, in practice, valuation of the revenue-producing investment can only reflect from empirical data the imperfections of market values as the index of the social values which are of interest in plan evaluation; and they cannot make forecasts which are of sufficient sensitivity to reflect significant differences in quality of the alternative plans as a basis for comparison with planning objectives (LICHFIELD, 1968). EVANS (1969) has criticized the maximum land value formulation with the conclusion that "it is incorrect theoretically and inapplicable practically". However if it were to be applicable on the lines visualized by Lean and Goodall then it would attract the features shown in Table 1. On the whole it could only contribute a partial analysis for objectives, systems and sectors, would be silent as to producers and consumers, would not give costs and benefits but only their difference, which is of limited use as a criterion and would not give incidence.

8.4. *Cost–benefit analysis.* As indicated earlier under Section 4 above, cost–benefit analysis has a long history of application to public investment and policy projects. But it is only recently that it has been used for urban and regional planning. In the main this use has been the extension by economists of the analysis into the field. This approach is in contrast to that of the writer who has visualized the problem as a planner and attempted to adapt the technique of analysis to the purpose, thus leading to the Planning Balance Sheet which has been described above.

8.4.1. *Rothenberg.* ROTHENBERG (1967) has applied the analysis to the problem of urban renewal and has attempted to use it in particular cases. In the cases the costs are the resource costs of implementing the renewal project (that is excluding land acquisition) and the benefits are measured by increased site values. The difference is compared with the spillover effect in terms of increased values in neighbouring real estate and decreased social costs associated with slums.

This brief formulation shows that the analysis uses as the main source of benefits the increase in real estate site values and is therefore open to the same kind of criticism as was given in relation to land values in 8.3 above and also to objections as to use of meaning of real estate data in urban renewal situations. And any objections to using the index for a new town (as proposed by Lean and Goodall) must be increased when it is proposed to apply it in the complex situation of urban renewal, for then the interdependency with established real estate values offers complexity. Accordingly Table 1 shows the method has the same features as Section 8.3. It is only of limited application.

8.4.2. *Mao.* MAO (1966) also tackles urban renewal projects in the United States with an approach quite similar to that of Rothenberg. However he extends the analysis by attempting to measure the decreased social costs associated with the elimination of slums in terms of municipal savings and such matters as fire, health and police protection. A difference in the financial costs is struck which is then compared with the intangible costs and benefits that would be involved. This presents the essential decision framework for the decision maker. Thus the approach is more helpful than that of Rothenberg, by making more specific the social benefits from removing

slums and also throwing into the balance the intangibles which have not been measured. However the analysis as a whole is still partial in terms of Table 1.

8.4.3. *Roskill commission research team.* From the urban renewal analyses just mentioned to the cost–benefit analysis for the Third London Airport produced by the Roskill Commission Research Team (Commission on the Third London Airport, 1970) is a very big step, for the team has produced the most thoroughgoing cost–benefit analysis in urban and regional planning so far. Taking as the starting point four sites which have already been located for the airport by the Commission, the analysis explores exhaustively all the consequential costs and benefits that will flow and measures them, and concludes with a summary of best estimates of total costs and benefits. This summary is then adjusted by means of sensitivity analysis of certain of the variables. Since the cost–benefit analysis is so comprehensive, the question arises as to whether it is or is not the same as the Planning Balance Sheet appraisal, which applies cost–benefit analysis to urban and regional planning problems. The answer to this question can be given simply because a Planning Balance Sheet analysis of the identical four sites was also made for submission as evidence to the Commission at Stage III of the Inquiry (LICHFIELD and ASSOCIATES, 1969), thus enabling a close comparison to be made. The differences in methodology can be seen from Table 1. The Planning Balance Sheet is more specific on objectives. Both cover the total system and all the sectors and both attempt the measurement of all the costs and benefits, but the Research Team has measured all the items whereas the Planning Balance Sheet analysis, for want of time and resources, had to leave many as unmeasured. Accordingly the criterion for the cost–benefit analysis can be more easily formulated and used, and accordingly the analysis can be better used as an optimizing tool than can the Planning Balance Sheet. Further differences lie in the fact that the Research Team have not generated their results in terms of producers and consumers, there is no particular logic or order in the manner of treatment of the elements, and they have also not had full regard to the incidence of the costs and benefits.

These differences are ones of degree only. In a Planning Balance Sheet analysis there is every endeavour to measure what can be measured; but there is also the recognition that the time resources for such full measurement are not normally available so that recourse must be had to the treatment of measurables and intangibles in the same analysis. Equally well the Research Team could have, had they wished, made their approach to the analysis more operational by grouping the elements in more orderly form in relation to producers and consumers, and brought out the incidence more carefully.

In brief, where a cost–benefit analysis is carried out in a comprehensive manner, that is comprehensive in relation to the systems and sectors which are of interest in urban and regional planning, such analysis becomes in effect a Planning Balance Sheet. Put alternatively, although it must be recognized that the failure to measure costs and benefits leads to difficulty in interpretation of the results, a Planning Balance Sheet applies cost–benefit analysis as far as it can be taken in the absence of full measurement.

CONCLUSION

Thus we have completed the circle in this review of planning evaluation methodologies. As Table 1 shows, of all the methods that have been put forward, whether tried in practice or not, only the Planning Balance Sheet, or cost-benefit analysis, as used by the Roskill Commission Research Team, gives a sufficiently comprehensive treatment to justify the description of comprehensiveness in plan evaluation; and even these fall short on the ten criteria shown in Table 1.

This should not lead to discouragement in the U.K. of other plan evaluation methodologies, where the conclusions can be reached simply and quickly. Some conscious evaluation is better than the failure to generate and consciously compare alternatives. And the best here can be the enemy of the good.

But if it is the best plan which is sought then only the more comprehensive analysis can be relied upon to aid in its selection.

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