

Land use changes, sustainable development and evaluation analysis

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(Sintesi della Relazione)

1. Premessa

Fin da gli anni 70 gli aspetti conflittuali tra sistema economico (che comprende produzione, tecnologie e consumo) e sistema ambientale (che comprende le risorse naturali e manufatte) sono diventati oggetto di una intensa ricerca sia nei paesi più sviluppati che in quelli in via di sviluppo.

In molte realtà le questioni ambientali sono diventate fondamentali, a causa delle elevate forme di degrado. L'interdipendenza tra ambiente ed attività socio-economiche è risultata sempre più evidente.

In questo contesto la nozione di sostenibilità (Commissione Brundtland, 1987) è diventata un concetto fondamentale da cui partire per riorientare le politiche di intervento.

In particolare, sempre più si riconosce che l'uso delle risorse ambientali diventa un fattore nodale per attivare strategie di sviluppo sostenibile.

Un uso del suolo adeguato può consentire quello che può definirsi uno "sviluppo co-evolutivo" sia del sistema economico che di quello ambientale. Pertanto la ricerca di un attento uso delle risorse ambientali e del suolo diventa oggetto di sempre più attente attività di ricerca anche in campo economico, laddove la dimensione fisico-spaziale-naturale è rimasta per lungo tempo trascurata.

2. La valutazione per la pianificazione

La valutazione nella pianificazione del territorio ha lo scopo di

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strutturare in modo sistematico tutti gli aspetti rilevanti delle scelte politiche e di piano. Essa ha lo scopo di evidenziare in modo sistematico i pro ed i contro di ogni opzione per ciascun gruppo sociale e per aree geografiche diverse, con lo scopo di produrre la massima trasparenza nelle scelte.

La valutazione (per esempio per la conservazione del patrimonio monumentale/culturale/ambientale ovvero nella predisposizione di progetti aventi rilevanti impatti ambientali etc.) non può essere effettuata con successo ricorrendo a metodologie rigide che si inquadrino nella logica della ottimizzazione. E' più aderente alla realtà individuare soluzioni "ragionevoli" perché "soddisfacenti".

Nella pianificazione, la valutazione può essere considerata come una attività continua e non solo come una fase isolata, ovvero come un semplice "momento". Il processo valutativo possiede in effetti una natura ciclica, con continue integrazioni e feedback (cfr. Fig. 1 e 2).

3. I diversi metodi di valutazione

L'impossibilità di includere gli intangibili, ovvero gli incommensurabili, nelle valutazioni del tipo ABC; la natura conflittuale di molti problemi di pianificazione; la presenza di molti decisori etc. hanno suggerito di ampliare il campo delle tecniche di valutazione ai cosiddetti metodi multicriterio. L'elenco di tali metodi è molto lungo: dal metodo del trade-off al metodo del valore previsto, alla analisi di concordanza, al metodo del conseguimento degli obiettivi, ai modelli di utilità, a quelli del punto ideale, ai problemi della programmazione per obiettivi ai modelli min-max e via di seguito.

Il problema diventa allora: Quale è il metodo preferibile in uno specifico problema?

Il confronto tra i diversi metodi può essere fatto rispetto a molti parametri, agli obiettivi, al tipo di informazioni disponibili etc. (cfr. Tav. 1 e 2).

4. Un caso studio

Un esempio ormai classico di conflitto è quello rappresentato dal rapporto tra conservazione e sviluppo con riferimento ad una area urbana. Da un lato c'è la necessità di introdurre delle profonde trasformazioni per migliorare l'efficienza complessiva degli assetti fisici, spaziali, economici.

Dall'altro c'è la necessità di conservare un patrimonio che possiede valore storico-artistico-ambientale, ed il cui valore è difficilmente esprimibile in termini monetari.

Il modo con cui elaborare una valutazione di questo patrimonio è difficilmente coincidente con quello che ricorre a scale di valutazione cardinali-economiche; più facile appare il ricorso a valutazioni solo qualitative.

La applicazione della analisi di frequenza attraverso l'uso di valutazioni solo qualitative è il modo più semplice per individuare alcune risposte, almeno ad un primo livello di analisi.

Nel caso, ad esempio in cui 6 alternative di piano caratterizzate da un diverso rapporto conservazione/sviluppo e di 7 criteri rilevanti (miglioramento della qualità della vita, distribuzione degli impatti, minimizzazione dei costi, contributo allo sviluppo della occupazione, miglioramento della accessibilità, miglioramento e tutela della qualità visiva dell'ambiente) l'elaborazione di specifici indici combinati di frequenza/priorità consente di dedurre una graduatoria di preferibilità complessiva (cfr. Tab. 6)

1. Prologue

Since the beginning of the 1970s the actual and potential conflicts between the economic system (including production, consumption and technology) and the environment (including both natural and man-made elements) have become a subject matter of intensive research in both the developed and the developing world. And in many countries environmental pollution (notably air pollution, water pollution and noise annoyance) has been coped with fairly successfully. Abatement policies, however, have mostly been oriented towards pollution problems of a concrete - often local or regional - nature, witness the great many regulations that have been edicted in the field of industrial pollution, sewage and the like.

In the past decade our world has been confronted with some striking new phenomena in the interlinkage between the environment and socio-economic activities. One of those is the *globalization* of environmental impacts. Another is the *regionalisation* of often hardly visible but quite

substantial discrepancies in the utilisation of environmental resources. The *global* impacts of environmental pollution reflected inter alia in ozonisation, desertification, deforestation and acid rain have come as scientific surprises and are up till now hardly managed in actual policy-making. However, especially since the publication of the report of the Brundtland Commission (1987) an increase of interest in global environmental problems has taken place. In this context the notion of *sustainability* has become a key concept in prospective global thinking.

In the second place, the great many small-scale and marginal changes that take place with clear regional dimensions have to be mentioned. All these incremental phenomena which look hardly relevant by themselves but have severe environmental impact lead to the need for more coherent planning. In this respect *land use* becomes nowadays a focal point in the attention of policy-makers and researchers.

In the light of the previous observations, the question is increasingly raised whether in the field of land use a *co-evolutionary development* of economic conditions and environmental qualities is a feasible option (cf. Norgaard, 1984). Such a co-evolutionary development would imply a simultaneous (and preferably parallel) improvement of both the economic system and the environmental system (or, if one would like to adopt Pareto's principle: a co-evolutionary development would imply an improvement in one of the two systems without affecting the remaining one). Thus co-evolution takes for granted a balance between economic development (all quantitative and qualitative changes in the economy that lead to a positive contribution to welfare) and ecological sustainability (all quantitative and qualitative environmental strategies that serve to improve the quality of an eco-system and have also a positive impact on welfare).

It is noteworthy that the concept of welfare has to be understood here in a broad sense as the (individual or collective) utility derived from the availability or use of scarce commodities, no matter whether such utility attributes can be measured in monetary terms or not (the so-called *formal* welfare concept; see also Nijkamp and Soeteman, 1988). Consequently, also toxic materials, ionizing radiation, beauty of landscape, traffic safety, wholesome food or availability of shelter may be regarded as arguments of a welfare function.

The fact that both conventional economic factors and environmental goods may contribute to welfare and also have to be traded off against each other, does of course not imply that as an extreme case one of the two systems might be completely extinguished. Both economic and environmental systems need a certain minimum achievement level (or threshold value) in order to survive. For instance, Ciriacy-Wantrup (1952, p. 253)

several decades ago already advocated the use of a minimum bequest value in strategic environmental policies, in particular the establishment of safe minimum standards of conservation by avoiding critical zones brought on by human activities which make it uneconomical to halt and to reverse depletion. Thus the idea of a co-evolutionary development needs a careful consideration of sustainable threshold levels for both the economic and the environmental system.

It would be a mistake to believe that only modern land use is detrimental to environmental quality. For instance, the Greek philosopher Plato already complains in his *Critias* about the landscape changes in Attica which had turbed the environment into "... bones of a wasted body ... richer and softer parts of the soil having fallen away, and the mere skeleton being left" (cited in Clark, 1986, p. 8). But also in other European countries (e.g. Italy, Spain, England, the Netherlands) soil erodin, as a result of agricultural and forestry activities, has affected the landscape in all time periods between nomadic cultures and modern high-tech agriculture (see Wilkinson, 1973).

This new position of land use as issue of scientific research is different from that in the past. Apart from the period of physiocrats, when the productive capacity of the natural environment (mainly land) was regarded as the major source of welfare, other periods of history of economic thinking have paid less attention to land as an important production factor. For instance, in classical economics capital and labour, in addition to land, were regarded as the main welfare generators. Furthermore, the classical economists assigned only a minor role to the government being an institution for establishing the framework within which market decisions had to be taken. It is interesting to note that also the classical economists were aware of the possibility of a stagnating economy caused by lack of natural resources.

As a consequence of neo-classical thinking, it was taken for granted in the post-war period that nature is not the source of welfare, but only the welfare constituents produced by labour, capital and land. Clearly, land has not become irrelevant, witness also the following quotation of Randall and Castle (1985, p. 573): "... there seemed no reason to accord land any special treatment that would suggest its role is quite distinct from that of the other factors. Land could safely be subsumed under the broader aggregate of capital ...".

After the neglect of environmental factor in Keynesian economics, we are now facing a situation where the externalities and limits to growth (with regard to both renewable and non-renewable resources) have become a focal point of economic research. The major question is, however,

how to avoid a 'tragedy of the commons' (Hardin, 1968) in view of the long-term threats exerted by the (seemingly) inevitable and persistent changes in agricultural land use.

2. Evaluation for concerted planning

Evaluation aims at rationalizing planning and decision problems by systematically structuring all relevant aspects of policy choices (for instance, the assessment of impacts of alternative choice possibilities). Evaluation is usually not a one-shot activity, but takes place in all phases of decision-making (for instance, on the basis of learning principles). In addition, a systematic support to complex planning and decision problems presupposes a balanced treatment of too many details and too little information. Besides, the results of an evaluation procedure have to be transferred to urban and regional policy-makers in a manageable and communicable form, particularly because the items of an evaluation problem are usually multidimensional in nature (including incommensurable or even intangible aspects). Finally, it has to be realized that the planning environment is usually highly dynamic, so that judgements regarding the political relevance of items, alternatives or impacts may exhibit sudden changes, hence requiring a policy analysis to be flexible and adaptive in nature. Rigid evaluation techniques run the risk that an evaluation does not cover all issues of a regional, urban or transportation planning problem in a satisfactory way.

Any evaluation requires appropriate and balanced information. The aims of the evaluation however, may be different and depend on actual institutional and administrative interest. Three broad categories of behavioural paradigms may be distinguished for public decision-making:

- "optimizing" behaviour
- "satisficing" behaviour
- "justifying" behaviour.

Although the majority of formal evaluation techniques is focusing attention on the first category and to lesser extent on the second category, in policy practice evaluation is often used as a means of justifying policy decision, even if the actual decisions are not in agreement with optimizing or satisficing principles. In any case, however, relevant data for a policy judgement have to be collected. Such data should be represented through appropriate evaluation methods in an operation form in order to make the actual choice issues as transparent as possible.

As has been mentioned before, any policy decision will affect the

welfare position of individuals, regions or groups in a different way. Consequently, the public support for a certain policy decision will very much depend on the distributional effects of such a decision. Thus, in general, it is advisable to design or use evaluation methods that try to assess the pros and cons of a certain choice alternative for separate groups or regions. Information on such gains and losses are not always cardinal in nature, but also qualitative, fuzzy or verbal information may provide a meaningful input for a policy analysis. Altogether, spatial and/or social referencing of information is highly desirable to make evaluation more effective.

In all cases, there is a need to take into consideration all - sometimes conflicting - choice options and views. This leads to the notion of *concerted* planning and evaluation methods, in which an attempt is made at designing and using multidimensional judgement methods for a variety of different policy criteria.

3. Evaluation as a planning activity

Evaluation may be considered as a continuous activity which constantly takes place during a planning process. Even a limitation to a specific kind of evaluation does not change this characteristic, since there are always many choice-possibilities during a planning process which have to be assessed and judged. However, for reasons of clarity we will restrict in this paper the meaning of the notion of evaluation process to a set of coherent activities which involve the simultaneous evaluation of a set of alternatives. The word simultaneous have been used here to denote that traditionally an evaluation process only treats one planning component at a time, e.g., the evaluation of traffic circulation plans, the evaluation of alternative highway routes, or the evaluation of implementation schemes for physical planning, and so forth. It is noteworthy that evaluation processes have a cyclic nature. By cyclic nature is meant the possible adaptations of elements of the evaluation due to continuous consultations between the various parties involved in the planning process at hand. The degree of complexity of an evaluation process depends among others on the evaluation problem treated, the time and knowledge available and the organizational context.

Generally an evaluation process will have the following structure; see Figure 1. It starts with a definition of what has to be evaluated (step 1). Next, various alternatives must be defined (step 2). This may be very easy, for instance, in cases of locational decisions where regions or zones have

to be evaluated. Sometimes this step may be very difficult, e.g. the definition of policy alternatives, and in that case much attention should be paid to the procedure by which those alternatives are generated. So-called continuous evaluation methods (e.g. programming techniques) may then be appropriate.

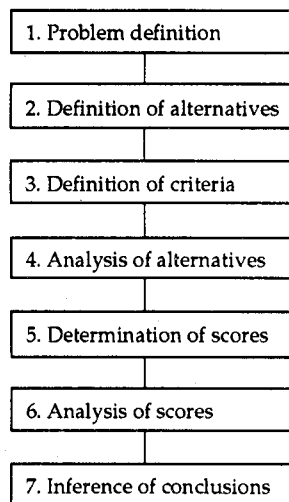


Figure 1. The structure of an evaluation process.

In addition, the relevant evaluation criteria have to be defined (step 3). These criteria can be used as a guideline for the analysis of the alternatives (step 4). For instance, if for an evaluation of transportation schemes several criteria have been formulated with respect to environmental issues, this may result, firstly, in a special environmental investigation of the alternatives, and, secondly in an analysis in depth of the aspects treated by the specific criteria. However, practical applications of multicriteria analysis show that this - efficiency and effectiveness increasing - relationship between step 4 and step 3 is not always drawn. In this context, multiple criteria evaluation can be very helpful in structuring the research

such that redundant analysis may be avoided.

On the basis of the investigations of step 4, in step 5 the criterion (or impact or effect) scores can be determined, such that one evaluation matrix (or more) can be constructed. In the next step these scores have to be analysed (step 6). This can be done by simply comparing the alternatives for each criterion and by listing for each criterion the strong or weak alternatives, or by applying discrete multicriteria techniques. In the latter case, often criterion priorities have to be defined, because otherwise the information from the evaluation matrix can not be amalgamated.

In the last step 7 of Figure 1 conclusions have to be drawn and recommendations have to be prepared for the client (decision-maker, etc.).

It is obvious that in this evaluation process, as outlined in Figure 1, many feedback loops may be recognised. Such feedback loops are a necessary ingredient in concerted planning and evaluation analysis.

In the light of the previous remarks, a concerted planning evaluation methodology may be represented as follows (see Figure 2):

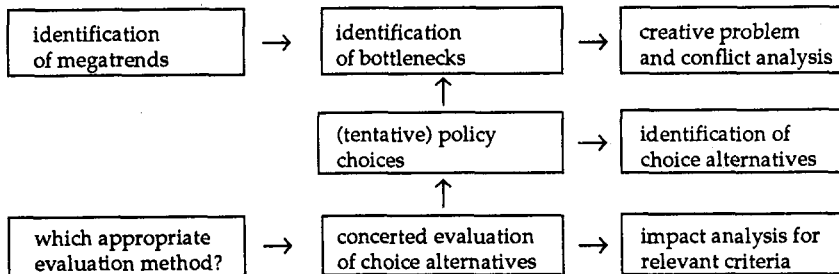


Figure 2. A systematic description of a concerted planning evaluation methodology.

This figure can be seen as the envelope in which the elements of Figure 1 are components. One question is left unanswered in this scheme, viz. which evaluation method has to be used for which planning problem? This will be further discussed in section 3.

4. The selection of appropriate multiple criteria methods

4.1 *A Review of Appropriate Multiple Criteria Methods*

In the seventies and the beginning of the eighties a real avalanche of multiple criteria methods has taken place, so that nowadays there is a wide variety of various multiple criteria decision methods. These methods are not only used in the context of conventional project and plan evaluation, but also as an operational framework for conflict analysis in a concerted planning endeavour (e.g. town planning, environmental management, regional planning, transportation planning).

The following reasons can be identified as contributing to the increasing popularity of these methods:

- the impossibility of including intangible and/or incommensurable effects in conventional evaluation methods (like cost-benefit and cost-effectiveness analysis);
- the conflictual nature of modern planning problems so that, instead of a single decision-maker, various (often multilevel) formal and informal decision agencies determine a final choice in participatory context;
- the shift from conventional 'one-shot' decision-making to institutional and procedural decision-making where a variety of strategic and opportunistic policy aspects play a role;
- the desire in modern decision-making not to be confronted with single unambiguous and (sometimes) forced solutions, but with a spectrum of open feasible solutions each having its own merits.

All this reasons have led to the current popularity of multiple criteria analysis in public planning. In the seventies and the beginning of the eighties a real avalanche of multiple criteria methods has taken place, so that at the moment there is a wide array of various multiple criteria evaluation methods for public planning and evaluation. These methods can be used for different purposes and in different contexts. The following distinctions can be made regarding the contents and scope of multiple criteria evaluation methods.

(1) discrete versus continuous methods

Discrete evaluation methods focus attention on a finite set of (a priori know) choice alternatives, whereas continuous evaluation methods are

- in principle - related to a non-countable (and hence not precisely identifiable) set of choice alternatives.

(2) multi-person versus single-person evaluation

In case of multi-person (or multi-committee) evaluation problems, it is

in general impossible to assume unambiguous and a priori known trade-offs, so that flexibility allowing for dynamic preference articulation and bargaining procedures has to be ensured. For a single-person case it is often easier to specify policy priorities.

(3) *identification versus selection of alternatives*

In various evaluation problems it is only necessary to identify a limited set of reasonable (or 'satisficing') choice possibilities, whereas in other cases the demands are put much higher, viz. the unambiguous selection of a single alternative. In the first case, it may be sufficient to find a set of non-dominated (or Pareto) solutions for which the value of one policy objective cannot be improved without reducing the value of competing criteria.

(4) *single-step versus multi-step evaluation procedures*

Single-step evaluation takes for granted that a given evaluation problem must be solved immediately, whereas multi-step evaluation assumes a process character for evaluation (e.g., learning mechanisms, adaptive information provision).

(5) *soft versus hard information*

Soft evaluation problems are characterized by non-metric information (e.g., ordinal data, qualitative statements), whereas hard problems are based on quantitative (e.g., cardinal) information. An intermediate case is *mixed* information, which includes both qualitative and quantitative information.

Despite the rich variety of multicriteria and multiple objective evaluation methods, they all have one element in common, viz. the existence of multiple 'judgement' (evaluation) criteria. In this regard, multidimensional evaluation has become an important mode of thinking, especially as it is able to take account of a wide variety of divergent aspects inherent in any decision or choice situation. Besides, it offers an operational framework for a multidisciplinary approach to wide-ranging physical planning problems.

Various classifications of multidimensional evaluation methods may be made. In this paper we will employ the following typology for these methods: discrete multiple criteria methods versus continuous multiple objective methods, and hard information methods versus soft information methods.

Discrete methods only display a finite number of feasible choice

possibilities (course of action, strategies, solutions, alternative plans or projects, etc.), while continuous methods may encompass an infinite number of choice possibilities.

Hard information means information measured on a cardinal scale, whereas soft information means information based on a qualitative (ordinal or nominal) scale. Clearly, one may also distinguish mixed information, in which the information is partly cardinal, partly qualitative.

Consequently, the following typology can be created (see Figure 3).

	cardinal information	qualitative information	mixed information
discrete multiple criteria methods	I	III	V
continuous multiple objective methods	II	IV	VI

Figure 3. A typology of multidimensional evaluation methods

In the literature on multiple criteria analysis most attention has been devoted to categories I and II. Well-known cardinal discrete methods of type I are: trade-off analysis, expected value method, concordance analysis and goals-achievement method. Trade-off analysis is essentially a method of selecting the best alternative to achieve a pre-specified benefit, given an unambiguous criterion (money, time, etc.). The existence of an unambiguous criterion makes it possible to compare expected gains against expected losses when considering the shift from one alternative to another.

The expected value method assigns a set of weights to criteria and treats these weights as quasi-probabilities, which add up to 1. Thus the expected value of the outcomes of each alternative can be calculated by multiplying the outcome (one each criterion) by its appropriate weight and then by adding up the various parts. Concordance analysis is a widely used multiple criteria analysis based on a pairwise comparison of alterna-

tives. This method measures the degree to which an alternative's outcomes and preference weights confirm or contradict the dominant pairwise relationships among alternatives. Finally, the goals-achievement method is a technique which relates objectives to quantitative achievement levels. Each criterion is assigned an index of relative importance. Then for each alternative outcome an achievement index is calculated, on the basis of which an aggregate achievement index for each plan is determined.

The following optimization models are well-known cardinal continuous methods of category II: utility models, penalty models, goal programming models, min-max models and ideal point models. Utility models are based on the assumption that the whole vector of relevant objectives can be translated through a weighting procedure into the master control of one unambiguous utility function. Thus, it presupposes a priori known trade-offs. Penalty models assume the existence of a set of desired achievement levels (i.e. ideal vector), so that any discrepancy between an actual value and an ideal value is penalized by means of a penalty function. Goal programming models are among the most frequently used optimization models. They are essentially a subclass of penalty models, where both over- and underachievement of ideal values are taken into account during the optimization process.

Min-max models are based on the use of pay-off matrix for conflicting objectives. When there are multiple objective functions (for instance, in case of many participant each with his objective function), the first step is a separate optimization with regard to each individual objective function. On the basis of the optimal value of each objective function a pay-off table representing the conflicts between the successive objectives can be constructed. Each column of this pay-off table pertains to a given objective function and each row pertains to a given strategy. In addition, an equilibrium solution for such a pay-off table can be identified, viz. the solution which is nearest to the set of ideal solutions presented on the main diagonal of the pay-off table. Finally, a related class of models, viz. ideal point models, can be mentioned. They are based on a distance metric for the deviation between ideal solutions on the one hand and a set of efficient solutions on the other hand. A compromise solution is characterized by a minimum distance between the ideal solution and one point from the set of efficient solutions.

Despite the large number of (simple and sophisticated) multiple criteria decision methods that are currently available, there is still surprisingly little insight into the conditions under which these methods can best be applied. Therefore, the present paper will especially focus on the question: which multiple criteria method is suitable for which class of

conflict analysis?

In this context, it is plausible to use a typological approach to classify multiple criteria decision methods on the basis of the features of different activities, of specific effects of these activities, and of the institution planning and policy structure of the planning problem at hand. By including problem and procedure characteristics in large matrices, a classification and sequential selection of multiple criteria methods may then be achieved. The present paper will draw on this approach and, in so doing, present a general conceptual typology of multiple criteria decision methods.

The typology presented here is primarily developed for decisions to be made by various kinds of governmental decision-makers, but it may in principle also be useful for decisions to be taken in the private sector.

Conflict management problems are in this paper characterized according to two dimensions: the activity profile and the decision profile.

4.2 The Activity Profile

The activity profile can be characterised by two aspects: the activity type, and the type of effects caused by the activity. For example, a conflict generating activity (being a stimulus in the form of a public decision) may be a project (e.g. the construction of a bridge), a plan (e.g. a physical plan for urban renewal), or some form of public regulation from a government (e.g. the establishment of environmental standards). There are numerous ways to classify the effects of such activities. Effects can be differentiated according to their temporal, spatial and other characteristics. An effect may be unique, repetitive, continuous short-term, or continuous long-term. It may also be stationary or mobile, and/or within or outside the boundaries of the decision unit involved. The effect may be equally or unequally distributed over the parties involved. An effect may be compensatable (i.e. the gains of the winners are sufficient to compensate the losers) or non-compensatable. And finally, an effect may be submitted to formal standards or not.

4.3 The Decision Profile

Decision profile characteristics can be subdivided into the solution space and the decision space. The solution space comprises the alternatives set and the information features. For example, the alternatives set may be composed of one, few or many alternatives, or it may be a continuous set. Information available regarding the conflict problem may be quantita-

tive, qualitative, or mixed. It may also be certain, uncertain with a known probability distribution, or uncertain with an unknown probability distribution. Finally, information may be limited or extensive, agreed or not agreed on. The decision space comprises institutional characteristics, characteristics of decision-makers, characteristics of required decision results (e.g. efficiency) and available means for the decision-making process.

In terms of institutional characteristics, for example, the decision may be based on one or multiple objectives, may involve two, three or more parties, and one or more decision levels. The decision procedure can be hierarchical or participatory and may be influenced by external interest groups. Finally, a distinction can be made between routine and non-routine decisions. In terms of characteristics of decision-makers, they can have an analytical or heuristic attitude, can be optimizers or satisficers, can be short-term or long-term oriented, and risk-lovers or risk-aversers (see for a systematic presentation also Table 1).

Now the problem of using the most appropriate evaluation method in concerted planning can be solved by identifying from the set of available methods the one that has a maximum agreement with the planning problem under consideration.

5. An illustration in the field of town planning

In many cities a conflict exists between the aim of reorienting the urban structure toward a more modern and efficient spatial lay-out and the need to preserve the historico-cultural heritage. Various aspects of the historico-cultural heritage are hardly measurable in cardinal units, so that 'soft' evaluation tools have to be used. In the present section a numerical illustration of conflict analysis in this area will be given, based on the so-called frequency analysis. Here it is taken for granted that a city council wants to have indicative information on urban restructuring plans characterised by very imprecise information.

In this subsection first an introduction to frequency analysis will be given, based on the assumption that qualitative data cannot be added up, but that the frequency of occurrence of a certain type of qualitative data can be numerically treated.

Consider a choice problem with I alternatives and J evaluation criteria. Next, one may distinguish (without loss of generality) three

performance indices:

- +++ very favourable impact;
- ++ fairly favourable impact;
- + small favourable impact.

The assumption is made that all criteria are measured as benefit criteria ('the higher, the better'). Consequently, all cost criteria have to be redefined as benefit criteria.

It is evident that such 'soft' information is not very accurate, but it is a usual circumstance in many evaluation problems (for example, in monument preservation). The soft performance indices presuppose a certain frame of reference in order to assign the plan impacts to there performance classes.

In a similar way, qualitative priorities (weights) can be incorporated in qualitative importance classes. Suppose (again without loss of generality) the following two importance classes:

- XX very high priority;
- X normal priority.

Clearly, the assignment of these importance indices has to be based on a frame of reference regarding all plan impacts.

Next, one may construct a frequency table (Table 3). Each element of this table represents the frequency that a certain plan (or project) outcome (+++, ++ or +) occurs with a certain preference score (XX or X). In other words, the left upper entry of this matrix indicates the number of times that plan 1 has a very favourable impact (+++), which is regarded as very important (XX).

	XX	X
	+++++	+++++
plan 1		
"		
"		
"		
plan I		

Table 3. Frequency table of combined importance-performance indices

Next, one may first attempt to eliminate *dominated* plans. All plans which have lower frequencies than any given competing plan may be eliminated. This step is essentially equal to the elimination of inferior (non Pareto-optimal) points in multiple objective programming. The following step is the *selection* of the optimal plan. This selection may be based on certain reasonable hypotheses concerning the relative dominance of plan impacts. The following hypotheses regarding the combined performance-importance indicies are made:

$$(+++,\text{XX}) > (++,\text{XX}) \sim (+++,\text{X}) > (+,\text{XX}) \sim (++,\text{X}) > (+,\text{X})$$

where the symbols $>$ and $\sim$ mean 'preferred to' and 'approximately equivalent to', respectively. On the basis of these rules one may usually select the optimal plan (or at least the best plan) by comparing pairwise the rows of Table 3.

The frequency method will now be illustrated for preservation policy in the context of urban development planning. Suppose, a local government is confronted with the need for restructuring urban infrastructure in a city which has a wealth of historical monuments. Several solutions (i.e., alternative plans or scenarios) may be distinguished in order to cope with the conflict between economic development and structural decline of the monuments. Clearly, each solutions has certain advantages and disadvantages, given the available limited budget. After a through investigation of all plans its appears to be possible to represent the performances (effectiveness scores) of all plans by means of a qualitative impact table.

The following six feasible plans (thus I-6) may be distinguished for the urban development policy at hand:

- 1) a very modest change in the urban infrastructure, accompanied by a marginal improvement of all monuments;
- 2) a partial rehabilitation of most monuments and a partial demolition of others, followed by constructing new residential buildings without substantial changes in the urban infrastructure;
- 3) a better preservation of one half of all monuments and a demolition of all others, followed by the construction of new dwellings;
- 4) a complete restoration of a limited number of all monuments and a demolition of all others, followed by a construction of new residential buildings, on the basis of lower densities, but which a maintenance of the original urban layout;
- 5) a complete demolition of all monuments and a construction of new residential buildings and of a modern urban infrastructure;

- 6) an increase of tourist taxes so as to increase the budget for conservation of monuments and a partial demolition of less important ones.

Next, the assumption may be made that the local government wants to judge these alternative plans on the basis of the following seven criteria (thus, J-7):

- 1) the improvement of the urban and residential quality of life;
- 2) the socioeconomic distribution of the impacts of the new plans;
- 3) the costs of the alternative plans;
- 4) the impact on the urban employment;
- 5) the urban population density;
- 6) the accessibility of the city centre;
- 7) the supply of urban amenities.

It is clear that the cost criteria 3) and 5) have to be translated into benefit criteria, so that a high amount of costs will be represented by an effectiveness score +.

For the above mentioned urban development plans we now assume the qualitative impact table shown in Table 4. The local government has to decide on these plans on the basis of this impact table, given its own priorities regarding the evaluation criteria.

criteria	PLANS					
	1	2	3	4	5	6
1	+	++	++	+++	++	++
2	++	+++	+++	++	++	+
3	+++	++	+	+	+	++
4	+	++	++	++	+	+++
5	+	++	++	+++	+++	++
6	+	+	++	++	+++	+++
7	+	++	++	++	++	+++

Table 4. Qualitative impact table of monument conservation plans.

Next, the priority scores shown in Table 5 will be assumed for the seven policy criteria. Thus, the assumption is made that there is one priority score for each criterion (i.e., a linear qualitative weighting system). In the case of a non-linear weighting system a whole matrix of preference scores has to be constructed.

1	2	3	4	5	6	7
XX	X	XX	XX	X	X	X

Table 5. A vector of priority scores for monument conservation.

On the basis of Table 3 and 4 the frequency table of combined performance-priority scores can be constructed (see Table 6). Table 6 gives rise to fairly straightforward conclusions. First, several plans, may be eliminated, because it is seen easily that plan 6 dominates absolutely plans 1, 3, 4, and 5. After the elimination of plans 1, 3, 4 and 5, the only choice remains between plan 2 and plan 6. But it can also be checked easily that - in view of our priority hypothesis - plan 6 may be selected as the best policy decision. Thus it appears that frequency analysis is an easily applicable multiple criteria evaluation method. A disadvantage is, however, that in various cases it does not lead to an unambiguous solution.

plans	XX			X		
	+++	++	+	+++	++	+
1	1	0	2	0	1	3
2	0	3	0	1	2	1
3	0	2	1	1	3	0
4	1	1	1	1	3	0
5	1	0	2	2	2	0
6	1	2	0	2	1	1

Table 6. Frequency table of combined performance - priority scores.

Table 1. Activity and Decision Profile of a Compound Decision Problem

1. concordance analysis 2. frequency method 3. lexicographic ranking 4. permutation method 5. eigenvalue method 6. regime method 7. multidimensional scaling 8. metagame method 9. mixed data method 10. trichotomic choice 11. score card method 12. key issue matrix 13. Delphi procedure 14. postponement of decision	Conflict management methods: selected set	Given planning problem	
			The method is based on a continuous decision function
			The method is based on a decision function for discrete choices
			The method is able to handle quantitative information in an efficient way
			The method is able to handle qualitative or mixed information in an efficient way
			The method is able to process uncertain information
			The method produces immediately results
			The method produces efficient solutions
			The method gives insight into the distribution of effects over the interested parties
			The method leads to converging solutions
			The method is able to produce compromise solutions
			The method allows for the introduction of constraints
			The method maximises the chance on the best results
			The method minimises the chance on the worst results

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