



Integrating multicriteria decision analysis and scenario planning—Review and extension

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ABSTRACT

Scenario planning and multiple criteria decision analysis (MCDA) are two key management science tools used in strategic planning. In this paper, we explore the integration of these two approaches in a coherent manner, recognizing that each adds value to the implementation of the other. Various approaches that have been adopted for such integration are reviewed, with a primary focus on the process of constructing preferences both within and between scenarios. Biases that may be introduced by inappropriate assumptions during such processes are identified, and used to motivate a framework for integrating MCDA and scenario thinking, based on applying MCDA concepts across a range of “metacriteria” (combinations of scenarios and primary criteria). Within this framework, preferences according to each primary criterion can be expressed in the context of different scenarios. The paper concludes with a hypothetical but non-trivial example of agricultural policy planning in a developing country.

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1. Background and context

Our initial motivation for this paper was a concern that many quantitative decision analytic models do not adequately deal with the many uncertainties and risks that arise in long term strategic decision making contexts. We are particularly concerned with the use of multicriteria value models and, to some extent, decision trees and influence diagrams, but the same difficulties occur in using other quantitative models: we would contend all other quantitative models. French [9] has written on the different forms of uncertainty that may arise in decision modelling and analysis and this paper to some extent extends that to thinking into the different contexts recognised by Snowden’s Cynefin model discussed below. Belton and Stewart [1] provide a detailed discussion of the issues involved in dealing with uncertainties in multiple criteria decision analysis (MCDA); and French [10] discusses the varied roles of sensitivity analysis in addressing particular forms of uncertainty. There are, of course, many other

discussions of how uncertainty might/should be addressed in decision analysis in the literature: for instance, Berkeley and Humphreys [2], Durbach and Stewart [7], and Durbach and Stewart [8], Graves and Ringuest [20], Jiménez et al. [22], Morgan [32], Morgan and Henrion [33], Papadopoulos and Karagiannidis [34], Roy [39], and Walker et al. [48].

Given that some of the motivation for our work came from considerations of strategic energy planning (e.g. [16]), it is interesting to note that problems of (multicriteria) decision making under uncertainty have received particular attention in the area of power systems planning, for example in Crousillat et al. [5], Gerking [17], Gorenstin et al. [19], Linares [26], Millán et al. [27] and Miranda and Proença [29]. This work recognised the need to balance risks by explicitly considering performance under different scenarios, and thus parallels much of our discussion below. The approach is primarily integrated into (multi-objective) mathematical programming rather than the discrete strategic choice including qualitative goals, which is our primary theme. We also seek a more formal basis for integrating performance under different scenarios with concepts of multicriteria decision analysis.

Building primarily on work by Wright and Goodwin [51], Goodwin and Wright [18], Stewart [44], Montibeller et al. [31] and Schroeder and Lambert [40], we discuss here how the use of scenarios to articulate a family of related decision analyses may

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help address some gross uncertainties which can arise in dealing with strategic issues and/or long time horizons. Moreover, although our motivation grew from consideration of how uncertainties might be addressed, we also explore the use of scenarios to articulate discussion between different stakeholders, allowing each to explore their preferences between alternative strategies in the context of a range of future worlds: some representing how they would like their political and social environment to evolve, others less desirable futures.

Our broad aim in this paper is to review and explore synergies between two streams of management science: *quantitative decision analytic modelling*, particularly MCDA and multiobjective optimisation approaches, and *scenario planning*. Although we refer to decision analytic modelling, we would emphasise that our discussion embraces process and behavioural issues in both of the streams to which we refer. We shall also use the term *scenario-thinking* to include any use of scenarios to inform analysis and deliberation, reserving the term *scenario-planning* for the approach and processes that derive from the work of Van der Heijden [46] and his colleagues at Shell. Our approach is to review various scenario based and multicriteria decision making approaches, focussing particularly on integration of these concepts, after which we propose a framework for integrated decision analysis. In this approach, we shall address two general themes:

- **What does scenario-thinking offer to the practice of decision analysis, particularly MCDA?** Probability is used to model uncertainty in the formal quantitative decision models to which we usually subscribe, viz. Bayesian decision analysis based on subjective expected multiattribute utility models [15,24]. However, the incorporation of complete multivariate probability distributions on performance measures (*attributes* or *criteria*) into formal multicriteria models raises many implementation issues. We shall argue that the framework given by a well-chosen set of scenarios provides opportunities for circumventing some of these. For instance, if we can capture gross uncertainties through the differences *between* scenarios, then we may be able to articulate the uncertainties *within* scenarios through tractable and assessable probability distributions or even work with deterministic models and carefully structured sensitivity analyses. However, scenario thinking offers much more to the practice of quantitative decision analysis than simply a tractable way of addressing gross uncertainties. In the problem structuring, value elicitation and strategy construction phases, a focus on distinct scenarios can provide greater clarity of thought and communication to the process. It may help participants see and explore contingencies [15]. Moreover, there are circumstances in which preferences may be conditional on the structure, both in terms of the attribute tree and the form of the multiattribute value function [14]. It may elucidate causes of conflict between participants, perhaps because each may have been thinking in terms of different scenarios. Above all, it can stimulate creative thinking, e.g. helping to design strategies which perform well in terms of goal achievement across scenarios, which can perhaps be viewed as robustness to uncertainty, although as we shall observe later, a mechanical interpretation of robustness in terms of variability across scenarios may not fully capture “robust” goal achievement concerns. Other concerns include accommodation of concerns of stakeholders and the representativity of the selected scenarios.
- **What does decision analytic modelling, especially MCDA, offer the practice of scenario planning?** Just as the introduction of scenarios into a decision analysis can elucidate

preferences and conflicts, so the explicit introduction of evaluation criteria into scenario planning can catalyse creativity and clarify the goals of the different participants. It introduces value focused thinking with all the ensuing benefits [23]. The practice of scenario planning includes evaluation of potential strategies in terms, for example, of their robustness in some sense, often not quantitatively defined across scenarios. This evaluation is typically not supported by formal analysis nor any checks on consistency. Decision modelling within each scenario could provide a template for more structured evaluation that may avoid the dangers of overlooking some important concerns or interests (criteria). As there certainly exist MCDA tools and models that can cope with ambiguity and imprecision of preferences, the appropriate MCDA could provide valuable support to the evaluation phase of scenario planning.

It is our contention then that the scenario-thinking which has underpinned the development of scenario planning can also bring huge benefits to decision modelling; and ultimately we seek a seamless integration of scenario planning and quantitative decision analysis. Taking the two approaches together may enrich deliberation by allowing the construction and evaluation of alternatives to include consideration of their advantages or disadvantages for different criteria under different scenarios. Ours is not the only work in this area and there are parallels with that of, *inter alia*, Goodwin and Wright [18], Wright and Goodwin [51], Montibeller et al. [31], Montibeller and Franco [30], and Schroeder and Lambert [40].

Some of our thinking has been shaped by Snowden’s Cynefin categorisation of decision contexts [41], and illustrated in Fig. 1. Cynefin is the Welsh for “habitat,” or at least that is its narrow translation; Snowden [41] indicates that it also contains connotations of familiarity. He originally developed the model to support discussions of knowledge management, but it has a much wider range of applicability [11,12,42]. Thus although his formulation is not commonly referenced in the literature on either decision analysis or scenario planning, we believe it provides a framework for thinking about the integration of these areas.

The Cynefin model roughly divides decision contexts into the four spaces indicated in Fig. 1. In the *known space*, or the *Realm of Scientific Knowledge*, the relationships between cause and effect

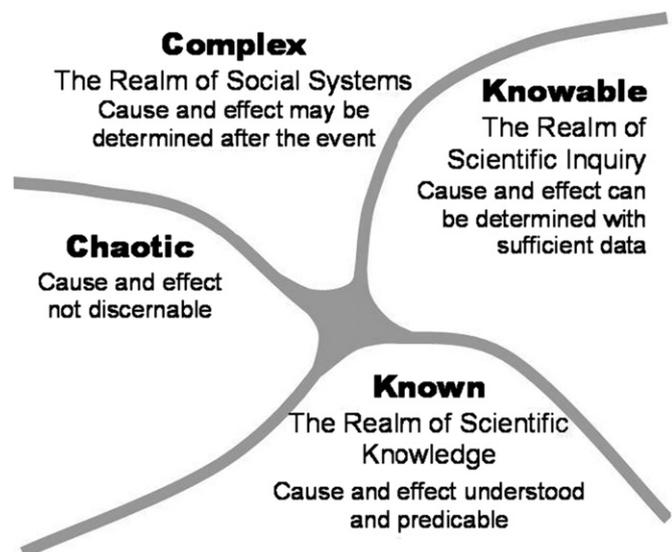


Fig. 1. Snowden's Cynefin categorisation of decision contexts.

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