Scenario analysis to support decision making in addressing wicked problems: pitfalls and potential

Abstract

This paper provides a review and evaluation of the use of scenario methods from the Intuitive Logics (IL) school to address so-called 'wicked problems'. Scenario planning has been widely advocated by its practitioners and its popularity has increased in the practice arena since the Millennium. However, some academics have described the technique as an 'art' that lacks theoretical and methodological rigour. Over recent years, academics have responded to this critique, drawing on both empirical and conceptual studies. This has led to a multiplicity of augmented IL scenario methods. Here, we review these developments and compare them to soft OR methods as a means of tackling wicked problems, drawing, in particular, on Churchman's moral imperative that we must address the whole problem, not merely 'carve off' one part. We conclude that IL scenario planning can be a useful tool in the OR practitioner's tool kit and that it can complement many of the established soft OR methods.

Keywords: scenarios; intuitive logics; soft OR methods; wicked problems; decision making.

1.0 Introduction

This paper presents an overview of the contemporary status of scenario methods from the Intuitive Logics (IL) school. Specifically, the text explores the potential of IL approaches in exploring so-called 'wicked problems', as defined in the OR field by Churchman (1967). Here, a wicked problem is one that is, "ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing" (Churchman, 1967, p. B-141). Additionally, it identifies those approaches that address Churchman's moral imperative that, "whoever attempts to tame a part of a wicked problem, but not the whole, is morally wrong" (p. B-142).

In narrowing the approach to address scenario planning methods from the IL school, the paper first discusses the principles of these in relation to the other two dominant schools of scenario planning; the French La Prospective, and Probabilistic Modified Trends (PMT) methodology (cf. Amer et al., 2013; Bradfield et al., 2005). Then, in considering the application of IL methods to address wicked problems, the text considers scenario analysis in relation to other soft OR methods, including those commonly used in organizational interventions (see Rosenhead & Mingers, 2001), namely: soft systems methodology (SSM) (Checkland, 1985), the strategic choice approach (Friend & Hickling, 1997), and SODA/Journey Making (Eden, 1988; Eden & Ackerman, 2013).

Scenario planning has been widely used in both public (e.g. Centre for Strategic Futures; Foresight Horizon Scanning Centre) and private (e.g. Courtney et al, 2013; Roxburgh, 2009) sectors over decades, with an increase in interest in the aftermath of the terror attacks of September 2001 in

New York and Washington. The origins of scenario literature lie to a large extent in the publications of practitioners from the Royal Dutch Shell organization (e.g. Schwartz, 1991; Wack, 1985a, 1985b). Emerging from the practice arena, scenario planning was the target of critique by business academics (e.g. Mintzberg, 1994; Mintzberg, Ahlstrand & Lampel, 1998; Porter, 1985), who argued that it was more of an 'art' than a management science approach.

While this paper outlines the practice origins of scenario planning, it also addresses these critiques in terms of more recent academic studies that have extended both conceptual and empirical debate of scenario methods. The key focus of the paper is to provide a summary review of key developments in this literature, of their contributions to both theory and practice, and with consideration of their relevance for, and application in, the field of OR in response to wicked problems and with regard to Churchman's (1967) moral imperative, calling for an holistic approach to such problems.

2.0 Challenges for strategic decision making in the face of wicked problems

Recent events with far-reaching consequences, but that were largely unforeseen; such as the financial crisis of 2007, the BREXIT vote in the UK, and the election of Donald Trump in the USA; have drawn attention to the high levels of uncertainty faced by strategic decision makers. Events such as these have impacts over extended periods and at a global scale, shaping the socio-economic and geo-political macro-environment, and being largely beyond the control of single organizations and their decision makers. The uncertainty inherent in the environment within which strategic planners operate serves only to increase the complexity of organisational decision making. In recent decades, there has been increased attention to such 'wicked problems', a term first applied by Rittel and Webber (1973) in the field of planning and public policy. These writers contrast 'wicked' problems – that they also describe as 'malignant', 'vicious', 'tricky', or 'aggressive' – in the social arena with what they term 'tame' or 'benign' (p. 136) problems in the natural sciences. They posit that while the latter are generally solved by finding 'the answer', the former are subject to "elusive political judgment" (p. 136) and, as such, are never 'solved', only resolved in the most appropriate way.

Rittel and Webber identified ten characteristics of wicked problems. (1) they lack a definitive formulation; (2) they have no stopping rule –constraints on time or resources or the perception that the current resolution is 'good enough' will determine when work on the problem is terminated; (3) resolutions of wicked problems are not true or false –they can only be judged as 'good', 'bad', 'better' or 'satisfactory'; (4) there is no immediate or ultimate test of a resolution of a wicked problem - the repercussions and impacts of the resolution will occur in a virtually boundless future and may be unforeseen and unintended; (5) every resolution is a 'one shot' operation with significant consequences, which precludes the ability to refine a solution through trial and error; (6) it is not possible to enumerate an exhaustive set of potential solutions; (7) every wicked problem is essentially

unique; (8) every wicked problem is the symptom of another problem; (9) the choice of explanation of the problem and hence its resolution depends on the analyst's world view; and (10) decision makers are held responsible for the consequences of the actions they take in attempting to resolve a wicked problem. In the face of such complex and ambiguous problems, the value of traditional decision-support tools, such as optimising techniques or decision trees have been called into question. (Goodwin and Wright, 2014).

In the strategic planning context the challenges posed by wicked problems are compounded by two factors. First, where the decision making process in response to a wicked problem involves multiple organizations, there are likely to be a variety of stakeholders involved in, and affected by, the process. As such, differences in disciplinary perspectives may be attenuated by divergent, and possibly conflicting values, priorities and stakeholder expectations. While there may be an expressed shared interest in the problem, it is likely that some stakeholders' key focus and interest may lie elsewhere and in potential conflict with the stated intent (cf. Vangen, 2017). Such issues of conflicting priorities, levels of information exchange, and degrees of common interest and involvement in application of soft OR methods have been highlighted and problematized (cf. Joldersma & Roelofs, 2004). Hence, what might appear on the surface to be a straightforward issue may well be perceived and understood in very different ways within the 'multiple realities' (Beech and Cairns, 2001) of organization life, even by members of a seemingly cohesive and committed group.

Second, as implied by Rittel and Webber's fourth characteristic, decisions will be made within the context of high levels of uncertainty about the future The human brain is limited in the number of concepts it can process simultaneously (Hogarth, 1987) so, unaided, decision makers are likely to have difficulty in addressing the potential interplay and impact of a large number of 'driving forces' – those political, economic, social, technological, ecological and legal factors that will impact on a wicked problem and whose alternate resolutions will drive different futures (Postma & Liebl, 2005; Schwartz, 1991). Aleatory uncertainty is present where probabilities can be attached to potential outcomes based on *a priori* reasoning or empirical frequencies of specific outcomes in similar events. However, in the future, unique, rare, or hitherto unwitnessed events may determine the success of a chosen strategy when tackling a wicked problem. Some of these events, so-called 'black swans' (Taleb, 2007), may have the potential to cause huge impacts. Moreover, events may appear 'out of the blue' without any apparent evidential basis in the present (Derbyshire and Wright, 2014). Some events may fall into the category of 'unknown unknowns' or ontological uncertainties (Ilmola and Rovenskaya, 2016).

In reviewing IL scenario methods as relevant to wicked problem resolution and in comparison to extant soft OR methods, two questions come immediately to mind. First, IL scenario methods address potential future outcomes to such problems, but to what extent, if any, do they directly inform the

decision making process? Second, soft OR methods are designed to support decision making in the face of complex and ambiguous problems, but to what extent, if any, do they provide a framework for structured consideration of the full range of potential futures? Before addressing extant IL scenario methods, this paper first considers key issues in the OR field.

2.1 Wicked problems in the context of OR development

Over the past decade, there has been only a couple of mentions of the term 'wicked problem' in the pages of the *European Journal for Operational Research* (Hector, C et al., 2009; Mingers & White, 2010). Both sets of authors refer to the 'mess' of such problems and the need to address the multiple 'worldviews' or 'perspectives' of a range of 'stakeholders'. While adopting different core foci, both articles are concerned with the search for more effective problem structuring approaches through the application of soft systems methodologies. Hector et al. (2009) specifically address the philosophical foundations of alternative worldviews, and clearly state their own stance as a, "moderate form of 'critical realism'" (p. 697), whereby, "while 'Truth' exists – there is an objective 'fact of the matter' and all propositions are only either true or false – for some problems, we cannot unequivocally determine the truth or falsity of the proposition at issue" (p. 697). Here, we seek to expand OR methods through reviewing IL scenario methods from an alternative stance, grounded in Aristotle's (350BCE/2004) philosophy and his 'intellectual virtues'.

Aristotle outlines three key 'virtues' that underpin our understanding of the world and our responses to it, namely: *episteme*, *techne* and *phronēsis*. The first of these addresses scientific knowledge that is eternal, universal and teachable. The second describes knowledge of production, of "something that is capable of being or of not being" (p. 149). The third virtue, *phronēsis*; 'prudence' or 'practical wisdom'; is "concerned with acts that are just and admirable and good for man (sic)" (p.162). Adopting an Aristotelian stance leads us to posit that absolute 'truth' lies only in the field of the epistemic – universal, non-contextual and teachable knowledge. In seeking to respond to wicked problems in line with Churchman's (1967) moral imperative, we are concerned with understanding through *phronēsis*, with knowledge to inform action for the good of humanity. Contemporary interpretation of *phronēsis* as practice (Flyvbjerg, 2001, 2003) leads us to consider the centrality of issues of power and rationality in how such problems may, or may not be addressed, and to whose benefit and whose loss. As such, in reviewing IL scenario methods, while we have concern for rigour of the method, our core focus is on questions of to what effect the method has on resolving the problem at hand.

3.0 Desirable attributes of methods designed to tackle wicked problems

Consideration of the core intent of seeking resolution of the wicked problem leads to six key assertions to underpin an idealised framework, namely:

1. The approach to tacking the problem should have a sound theoretical underpinning. Without this underpinning, the approach to the problem 'can never be fully understood or validated' (Chermack, 2004).
2. Wicked problems are by nature complex and ambiguous. As such, they must be analysed through a process of structured decomposition to expose their full complexity, and to ensure that they are not subject to reduction and potential exclusion, thereby fulfilling Churchman's (1967) moral imperative that they must be 'tamed' in their entirety.
3. They involve a broad constituency with varying beliefs and values, and with different degrees of power. Exploration must therefore engage the full range of both involved and, potentially, impacted stakeholders, taking account of those that are remote and often excluded, and of future generations
4. They are subject to multiple cultural, value-based interpretations, yet capable of rational analysis. As such, investigation must provide a forum not only to bring relevant rational, scientific knowledge to the table, but also to allow challenge to extant mindsets and discussion of competing rationalities as to how such knowledge is interpreted and acted upon, in a non-threatening environment
5. The approach should acknowledge and respond appropriately to uncertainty where it exists
6. The aim must be to seek resolution of the problem, not merely analysis, following the principles of *phronēsis*, as thinking to inform action for the good of humanity. So, there should be an outcome of a set of articulated actions, with allocated responsibilities and timescales for achievement.

From each of these assertions, a basic attribute of the idealised model is developed, as follows.

3.1 Attribute #1: Sound theoretical underpinning

Without theory we can have no understanding of how a method works and why it is appropriate for tackling particular wicked problems. Anecdotes that make claims for the success of a method in a given circumstance yield insufficient evidence of the general efficacy of the method. An explicit theory also allows for the possibility that its propositions can be empirically tested.

3.2 Attribute #2 Making sense of complexity through structured analysis

First, given the need to support decision makers in making sense of complex and, possibly, puzzling situations (Pidd, 1996), the method should facilitate structured decomposition of the decision problem (Arkes et al., 2010; Pidd, 1996, p102), but without reduction and exclusion (Checkland, 2000; Pinson et al. 1997). Axiom-based structured decomposition and subsequent re-

composition enables complex judgmental tasks to be broken down into simpler sub-tasks, thereby overcoming the limited cognitive processing capacity of the human mind (Bolger and Wright, 1992; Ozer, 2008). It also allows for division of labour between participants, enabling specialists to contribute where they are most needed and enables objective data to be used where it is available. As such, it should allow a wider range of issues, and their interaction, to be addressed and, in particular, should lead to the acknowledgement of uncertainty. Structured decomposition also allows individuals' thinking to be documented, making it transparent to other participants in the decision process. This should permit acknowledgement and recognition of potential differences in priorities and key objectives. It should therefore lead to open discussion on finding common ground around a focal issue of concern.

3.3 Attribute #3: Participative inquiry involving all stakeholders

Second, the method should allow group-based involvement in the development of strategy through a process that Franco and Montibeller (2010) refer to as 'facilitated modelling'. Similar approaches have been used in other fields, such as system dynamics, where they have been referred to as group modelling, cooperative modelling and shared vision planning (e.g. see Tidwell and Van Den Brink, 2008). Facilitated modelling differs from traditional operational research (OR) practice, where an analyst builds a model based on interactions with a client and then recommends a course of action. Instead, it involves the analyst acting as a facilitator and working alongside the client though the entire modelling process. As such, it involves both group facilitation and participative modelling in a workshop setting (Franco and Rouwette, 2011, Hodgkinson et al., 2006). Franco and Montibeller argue that a facilitated mode is suitable in interventions where, inter-alia, the problems are socially constructed entities, where subjectivity is unavoidable and where participation increases commitment for implementation. Such a process should provide the opportunity for 'democratic conversation'. This will ensure that key questions are addressed openly, whilst acknowledging the unavoidable play of power, politics and competing rationalities to achieve legitimacy (Checkland, 2000, Ackermann, 2012, Hamel, 2000 . The process associated with the method will be sensitive to the receptiveness of the organisation and the group composition and will be able to cope with any time constraints on participants' availability (Eden, 1992).

3.4 Attribute #4: Presenting challenge to current mindsets in a non-threatening environment

Further, given the dangers of overly restricted mental frames and strategic inertia, the approach should include mechanisms that provide challenges to participants' current thinking (Glick et al., 2012). It should also help to mitigate biases arising from the use of simplifying mental heuristics (Kahneman, 2011). An ideal process will therefore impose no constraints on the development of new thinking and perspectives and will support adaptive organizational learning (Haeffner et al., 2012). To achieve this, it will need to enable the engagement of the 'broad' (Freeman, 1984) stakeholder

community, eliciting diverse values, beliefs and ethical frameworks in an open and inclusive conversation. It should also actively promote dialectical inquiry and Devil's advocacy, subject to the ground rules above (Schweiger et al.1989), and draw upon and integrate both internal expertise and that of external experts). Morecroft (1984) notes that the dialectic method is appropriate where there are widely differing opinions regarding a situation – such an approach forces people to explore and scrutinize issues in depth and to justify the logic of their thinking.

3.5 Attribute #5 Acknowledge and respond appropriately to uncertainty

The existence of uncertainty, in both the present and the future should be acknowledged and confronted and the approach to tackling the wicked problem should support the design of robust strategies that are intended to perform acceptably whatever the future may bring (Pidd, 1996, p.43, Rosenhead, 2001). Such a strategy is likely to be flexible –for example, 'get out' clauses can be inserted in contracts -and involve redundancy so that spare resources are available to cope with unforeseen demands

3.6 Attribute #6: Articulated action, responsibility, implications and impact

Finally, the method should inform decision making, linking organizational priorities to broad social/environmental (moral) needs and providing a recommended course of action . It should prompt the development and discussion of policy options and their joint implementation by stakeholder groupings through their articulated action (Franco, 2006). It will be perceived by participants as being useful, credible and relevant, leading to implemented actions and, where appropriate, it will act as a catalyst for change. There will be an allocation of responsibility for action and an end date will be set for reporting back on progress (Bernardo et al., 2017, Elbanna et al., 2016, Miller, 1997). At the end of the process there will be an organisational memory and transitional object to influence the implementation of strategy (Eden, 1992). As such, the outcomes of the process should provide clearly articulated actions for all stakeholders, with an audit trail of reasoning, including identification of 'winners' and 'losers'. There will be both, since we are not dealing with moral relativism.

4.0 Soft OR methods for tackling wicked problems

The emergence of soft OR has its roots in the period of 'disciplinary malaise' (Rosenhead,2006) which emerged in the 1960s and extended into the 1970s and 1980s when some took the view that OR had restricted itself to 'tame' and relatively well-defined problems (Churchman, 1967). Ackoff's writings of this time (Ackoff, 1979) and later the works of Mingers (2000) and others (e.g., Rosenhead, 1990) exemplify the concerns over OR's apparent inability to effectively structure,

"messy, complex problem situations", "*exploring* the differing views and perspectives of the stakeholders", and "*facilitating* participation and engagement" (p. 674, emphasis in original).

In recent years, the field of soft OR has undergone somewhat of a rebranding with the introduction of the term PSMs or Problem Structuring Methods. In relevant literature, there is currently no distinction between soft OR and PSMs with some using the terms interchangeably (Mingers 2011). In this paper we have chosen to use the term soft OR since scenario methods go beyond the phase of structuring problems.

In providing an overview of extant literature on the application of soft OR methods, many works focus on three predominant approaches: soft systems methodology (SSM) (Checkland, 1985), SODA and Journey Making both of which are based around the technique of cognitive mapping (Eden, 1988, Eden & Ackermann, 2013) and the strategic choice approach (SCA) (Friend and Hickling, 1997). We briefly introduce each of these approaches here and illustrate their application through selected case studies.

4.1 Soft Systems Methodology (SSM)

Reprising thirty years of soft systems methodology (SSM), Checkland (2000) highlighted the difference between systems that can be understood as 'hard', autonomous and capable of being engineered systemically, and those that he describes as 'soft', exhibiting 'complexity and confusion' that can be understood through systemic inquiry. SSM is a methodology for exploring human activity systems which Checkland describes as a learning system where learning about the situation helps participants find accommodations that lead them towards action.(Rosenhead & Mingers 2001) The methodology consists of seven stages which can be conducted in sequence, or considered as a set of guiding principles – see figure 1. A key concept to the methodology is the distinction between two worlds, the real world containing the problem situation and within which any subsequent action must be taken, and a virtual world where systems thinking about the real world takes place.

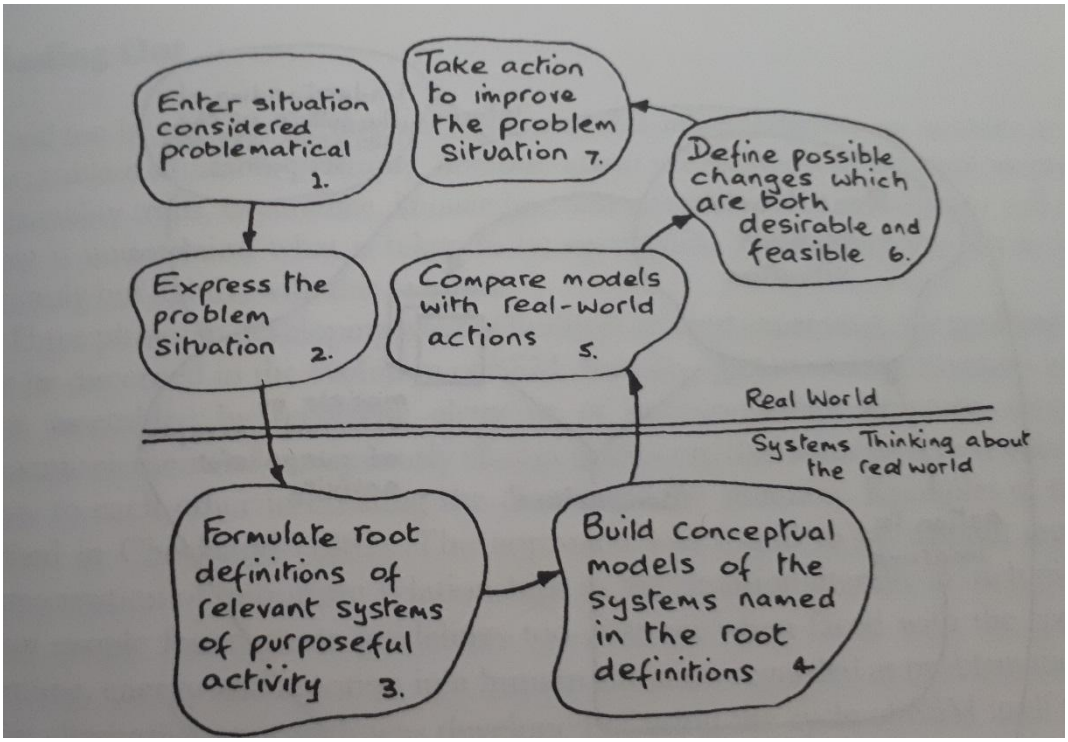

Figure 1: The early '7-stage' representation of SSM (Rosenhead & Mingers, 2001: p71)

Such inquiry into the nature of soft systems bears many similarities with scenario analysis. It calls for exploration of the problem situation, including its cultural and political aspects. It also requires inquiry into the nature of the actors, or stakeholders, and of their potentially conflicting interests. Importantly, SSM requires development of models, or systems, that are intended to, "improve the situation and are regarded as both desirable and (culturally) feasible" (p. S21). In setting out the 'basic' IL scenario method, van der Heijden et al. (2002) make frequent reference to 'systems thinking' as inherent to the process. In his retrospective, Checkland (2000) also recognises some aspects of SSM over time that are similar to the scenario field, first, where practitioner accounts are most frequently of claimed success, and lacking detailed methodological rigour.

4.2 Strategic Choice Approach (SCA)

SCA emerged from the work of practitioners within the Institute of OR and the Tavistock Institute supporting the development of strategic decisions and public policy. Consisting of four stages or 'modes of decision making' (Rosenhead & Mingers, 2001, p.118) it is designed to identify and analyse strategic decisions with respect to preferences and uncertainty. In particular the approach identifies three categories of uncertainty:

- uncertainty about the working environment – suggesting the need for further information
- uncertainty about the guiding values – suggesting the need for clearer policies

- uncertainty about choices on related agendas – suggesting the need for broader perspectives.

The methodology follows four stages or 'modes of decision making' (Rosenhead & Mingers, 200. p118): The first stage involves shaping the set of decision problems that decision makers face, debating how the problems should be formulated and exploring links and connections between them; issues of scope are also addressed, where for example a complex situation may be broken down into a series of sub-problems. Stage 2 focuses on designing the collection of options or courses of action that could possibly be used to address the set of problems highlighted in the shaping stage. In stage three, the set of options are compared against identified criteria and the three categories of uncertainty noted above. Importantly, note that the three categories do not explicitly encompass uncertainty about the future. The fourth and final stage involves choosing between the options and committing to action and reviewing alternative strategies for managing uncertainty through time.

4.3 SODA & Journey Making

Like SSM, in its early form, SODA (Strategic Options Development and Analysis) (Eden, 1988) was developed to focus more on the internal workings of an organizational context, offering a structured means of exploring a problem situation from multiple perspectives, making sense of different options for its resolution through consideration of the logics of causal mapping. Developed from Kelly's work on personal constructs (Kelly, 1955), SODA focuses on developing cognitive maps with individuals and then merging maps to form a single strategic map which is used for further discussion within a facilitated group setting, the objective of which is to gain commitment to agreed and negotiated action. In its more recently revised and augmented form, Journey Making (JOintly Understanding, Reflecting, and Negotiating strategY) (Eden & Ackerman, 2013), participants work within a group-facilitated setting to produce a joint cognitive map; extensions to the methodology embrace external environmental factors and used to support consideration of potential impacts of organizational courses of action in the broader societal context.

4.4 Combining soft OR approaches

While academic debate might refer to various OR 'methods', in the practice arena, these may well be referred to as 'tools'. To draw on the latter metaphor, we would posit that the OR practitioner, like the master craftsman, must have access to and knowledge of all the essential tools for undertaking the task at hand. These will each have unique strengths for a particular task, but they are not always uniquely placed to address that task – materials can be 'fixed together' using a hammer and nails or a screwdriver and screws. This paper argues that each of the soft OR methods briefly overviewed has its

own unique strengths, but also its area of overlap with others. Table 1 illustrates these points with a selection of the numerous documented applications of the soft OR approaches described above. .In illustrating the applications we have sought to present a small sample of cases that demonstrate the variety of deployments reported in the literature; we have selected one case associated with the originator(s) of the methods and at least one other example where the method has been fully or partially applied, sometimes in combination with one or more approaches. The final two columns in the Table are focussed on outlining how a particular soft OR method deals with (i) future uncertainty and (ii) decision making. As we will see later, it is on these two desirable attributes (see Section 3) that our evaluation of both the basic IL scenario method and its later augmentations will pivot.

INSERT TABLE 1 ABOUT HERE

The first three examples describe case studies where a single methodology has been applied, drawing on its particular strengths. Thus for example the explicit comparison of the two worlds (actual and virtual) within SSM was used within the NHS information strategy case to help highlight gaps and opportunities in the provision of support that a new strategy might address. The remaining examples illustrate cases studies where a methodology has either been augmented with additional approaches, as in the case of Journey Making, a development of SODA, or where elements of different methodologies have been combined into a multimethodology (Mingers & Gill, 1997; Bennett, 1985) as in the case by Ormerod (1995) where a bespoke methodology has been created to suit both the particular needs of the problem situation and the expertise of the facilitator.

In reviewing these cases and their use of the three classic soft OR methodologies described above, we compare them to the six desirable attributes of approaches for dealing with wicked problems identified earlier in the paper. Both SSM and SCA have strong foundations in practice whilst SODA/Journey Making was developed from the work of Kelly (1955). Importantly, note that these foundations do not utilise a normative axiom base, as in the underpinnings of the ”hard” OR decision analysis method. Attributes two and three are satisfied by each of the approaches since they each adopt a structured approach to dealing with the complexities of the problem situation often within a facilitated workshop setting involving a range of stakeholders. Each of the approaches contains elements that offer opportunities to challenge participant thinking, attribute four. For example SSM contrasts the current, real world with a virtual world developed from root definitions and activity models and SODA compares and merges the cognitive maps from different stakeholder participants. Each approach partially satisfies attribute five, but the uncertainty captured is typically about the present rather than the future, unless the approach has been augmented with this focus in mind. Finally the approaches differ in their approaches to identifying and committing to action, attribute six.

In the remainder of the paper, the strengths – and weaknesses – of contemporary IL scenario methods are discussed on the basis that they offer their own unique potential to enhance the range and capabilities of soft OR methods, particularly with respect to future uncertainty. First, a brief background to the origins and development of scenario method is presented, before moving on to review recent augmentations.

5.0 Scenario methods: origins, applications and critiques

Scenario methods are used as a means to elicit and synthesise expert opinion on potential futures and their codified origins can be traced back to the work of the American Rand corporation in the 1950s (Bradfield et al, 2005). Over the following decades, three main 'schools' or methods emerged and rose to prominence in the literature (Amer et al., 2013; Bradfield et al., 2005), namely: 'Intuitive Logics', the French-origin method of 'La Prospective', and 'Probabilistic Modified Trends' (PMT). The latter two school's methodologies share the commonalities of: (i) a focus on probability and the identification of the 'most probable' scenarios, and (ii) use of expert consultants who are familiar with the underpinning quantitative modelling tools. In contrast, the Intuitive Logics method is a qualitative, group-process-based approach that is focused on the development of multiple scenarios that explore the 'limits of possibility' for the future without regard to issues of probability, as opposed to the development of singular, 'normative' scenarios of some ideal future – as in applications of the La Prospective methodology.

In dealing with the range of possible futures, IL literature also refers to their plausibility. Here, plausibility becomes a socially-negotiated framing of what is seen as broadly reasonable, rather than an imposed constraint based on individual beliefs and values. A key focus in the scenario development process is the identification of the causal processes that lead to the unfolding of a particular future.

Because the Intuitive Logics (IL) method is not axiom-based, numerous variations have been published, varying from five to fifteen, or more, steps (Vanston et al., 1977). However, all share a common set of underlying principles, as set out below.

5.1 Fundamentals of the IL approach to scenario building

Outlining a number of then-current scenario approaches in the practice arena, Huss and Honton (1987, p.21) offered an overview of the IL approach as assuming that improved organisational decisions are based on understanding a complex set of relationships among economic, political, technological, social, resource and environmental factor that are the "driving forces" underpinning the unfolding of the future environment, lie largely outside the focal organization. In contemporary

scenario literature, these driving forces are generally listed under the acronym PESTEL, or similar (STEEPL, PESTLE, etc.), relating to stability/change in politics, economics, social factors, technology, the natural environment and legal structures (e.g. Buytendijk, Hatch & Micheli, 2010; Walsh, 2005).

Note that while the outcomes of particular driving forces may not be predictable, in considering different potential outcomes, there are linkages of cause/effect and chronology that may be seen as plausible and others that are implausible. Here, the strength of human 'disciplined intuition' (Jungermann and Thuring, 1987) comes into play whereby, for example: i) the election of one political party – of either a right- or left-wind persuasion – is more likely to prompt one line of policy priorities and practices than another on, say, issues of free health care provision or corporate taxation, or ii) the emergence of one set of variations to historical long-term climate conditions will support one particular change to agricultural production in a specific region over another.

Based on the exploration and analysis of identified driving forces, and of the plausibility of the links of cause/effect and causality, a number of future scenarios are then developed. Generally, the scenario narratives focus on critical issues that are central to the focal organisation's key strategic concerns and decision needs. In the basic IL approach, however, the focal organization is not an actor in the scenarios (van der Heijden, Bradfield, Burt, Cairns & Wright, 2002). Rather, the scenario storylines are intended to inform the organization's strategic thinking on how it might either thrive and survive, or wilt and die under each set of scenario conditions, thereby prompting appropriate policy and planning responses to enable strength and resilience in the face of the set of developed future scenarios. Notably, the basic IL scenario development process is, usually, conducted within a single organisation and involves many senior managers as part of an externally-facilitated "scenario team". In more sophisticated applications, the scenario team members are selected to represent different perspectives on a focal issue of concern and "remarkable people" - individuals with expert knowledge or unconventional but authoritative view on crucial uncertainties or perceived-to-be trends in the external environment - are brought into the process to challenge the scenario team's thinking by the externally-based scenario practitioners who are sensitive to issues of "groupthink".

Case & Source	Methodology used	Issues addressed	How uncertainty about the future was dealt with	How a recommended decision was identified
Information Strategy development at an NHS acute hospital (Checkland, 2001)	SSM	The creation of an information strategy within a large acute NHS hospital, involving a large group of NHS professionals.	Not reported in the case.	After conducting a CATWOE analysis, activity models for the major activities within the hospital were produced which were used to discuss the information support needed to carry out the activities. The current support provided was compared to that which was needed to undertake activities. Gap and opportunities were identified and used as the basis for a re-formulated information strategy.
Public policy development in the Netherlands (Hickling, 1990)	SCA	The development of a Liquid Petroleum Gas policy in the Netherlands relating to the landing, storage, transportation and shipment of the gas. The issues related to LPG were in the public conscience due to a recent (1978) accident involving LPG where a substantial number of	Focus is on managing and reducing three types of uncertainty (environment, related fields, values). Approaches were used to reduce uncertainty about the environment (such as risk analysis). For uncertainties identified late in the process or	Options were identified and compared against multiple criteria including how they addressed key areas of uncertainty identified. The resulting output was a commitment package which identified decisions to be made immediately (actions & further

		casualties had occurred.	which were not amenable to reduction, assumptions were made. For example how demand for LPG in the Netherlands would grow.	explorations) and those which could be deferred.
Participant involvement in planning for the Danish Forest & Nature Agency Hjortso (2004)	SODA – preliminary stages	The case sought to improve public participation (as represented by members of stakeholder groups via the user council) in a strategic forest management planning process.	Not reported in the case.	The early stages of the SODA methodology were followed (Individual cognitive maps produced from interviews which were then verified and used to produce an analysis of key issues). The resulting output was an idea and debate catalogue. Focus was on problem structuring and participant involvement rather than decision making.
Community planning for rural education in South Africa Phahlamohlaka & Friend (2004)	SCA & NGT (nominal group technique).	An exploration of strategic issues and a need to move towards an agreement on a package of actions that could be fed into the Trust's planning process.	The case notes that some uncertainty areas were listed but does not give details.	A deviation from the planned approach (identifying a set of options for comparison and choice). The deviation suggested the options could all be pursued in parallel, rather than some being delayed or not chosen; the participants accepted this suggestion.
Evaluating the operational function of a UK based intermediate care system (health & social care system	SSM & DES (discrete event simulation)	Evaluating a new system which was not well understood by those charged with its implementation.	'What-if' scenarios were used in the first phase of DES modelling to explore what the future might hold for the existing IC services.	SSM techniques were used to help structure the situation; CATWOE analysis and activity modelling were used to identify which primary tasks of the IC function should be in place in an ideal world, which in turn helped

for older people) Kotiadis & Mingers (2006)				to structure the evaluation issues. Two DES models were built, one of existing IC services used to assess resources, and one of the patient referral decision making process with a desire to improve on the current ad-hoc decision process
Modernising the UK's personal tax system Brown et al (2006)	SSM + Data mining	A study of the scope for modernising the operation of the UK's personal tax system. The study undertook to consult relevant stakeholders.	Not reported in the case.	Data mining was used to establish profiles of customer groups. SSM was used, in conjunction with the results of the data mining to learn about the current tax system and to take account of stakeholder views in generating ideas for change in the redesign of the system.
Information systems strategy development at Sainsbury's, Ormerod (1995)	Bespoke methodology drawing on elements of SCA, SODA, SSM, SWOT & other tools/methodologies.	The Corporate Systems Strategy Project was designed to build on previous successes with the company's information systems strategy. The project team consisted of senior managers from the main line departments led by the Data Processing department. The author of the paper was a consultant for PA at the time of the work and was brought in to facilitate the work.	Not reported in the case.	A bespoke methodology was designed drawing on a number of other tools and methodologies: Phase 1 – Business imperatives – understand the company & its environment – tools used: SODA (cognitive maps from individual interviews, merged into a single map); SCA (shaping mode); strategy & management tools (eg SWOT, Porter's five forces, de Bono's 6 thinking hats).

		The team were required to "…understand the current business processes, evaluate the future scope of technology and then to identify user needs and opportunities that would increase profitability, service and competitive advantage and would reduce cost." (p 280) The consultant (author) proposed an approach "…to work closely with Sainsbury's in a learning process, involving a new generation of managers, fostering creativity and mind broadening, producing an IT strategy that fits Sainsbury's, based on a shared understanding to generate commitment at Board level." (p281)		Phase 2 – Future systems – more detailed analysis of business areas selected in phase 1, in order to identify candidate systems for investment. The complete SSM methodology was used to support this phase. Phase 3 – Evaluation – the comparing and choosing modes of SCA were used. In addition, a quantitative evaluation was undertaken, using ideas from VSM. Phase 4 – Strategy – the prioritised portfolio of candidate systems developed in stage 2 were considered. No particular methods were used to support this phase – issues were debated and written up by the project team.
Scottish Natural Heritage, Eden & Ackerman (2002)	Journey Making including stakeholder analysis and scenario development	The client (CEO) wanted to surface the strategic issues facing the management team, considering a wide range of external factors, some of which they might want to manipulate. This work would contribute to the organisation's strategy development. He also wanted to consider the reaction of	Experts were used to support scenario development. Scenarios were used to test the strategic options being considered.	Multiple facilitated workshops were used over a period of time, some involving stakeholders. Collective ownership of the strategy was a key goal of the process. A variety of approaches were used in interviews and participative workshops including oval and cognitive mapping to

		stakeholders (internal and external). .		surface issues and emergent goals, stakeholder analysis and management, and scenario development. Some of the workshops were computer-assisted. The collection of analyses were used in a final participative workshop, involving some 50 senior managers, to develop a strategic action programme for each of 8 prioritised strategies.
Community involvement in water conservation, Foote et al (2007)	Scenario building and rich pictures (SSM)	Theory of boundary critique was used to design a problem structuring workshop to help reframe people's understanding of a 30 year conflict between the District Council and local community around issues of water scarcity and conservation.	Participants worked in one of six groups who were tasked with developing a best or worst case scenario associated with the water conservation campaign, universal water metering and planned infrastructure upgrade projects. Each scenario was presented visually as a rich picture.	Scenario building used to capture scenarios related to the Council's predefined technological proposals. Rich pictures to encourage participants to co-create a visual presentation of issues captured in each scenario. Suggested performance measure and possible implementation barriers were also identified.

Table 1: Illustrating applications of Soft OR approaches

We do not have space here to provide a full account of the basic IL method in practice, but such accounts can be found in the literature (Goodwin & Wright, 2014; van der Heijden et al., 2002; Cairns and Wright, 2018). Since the origins and much of the early literature on the IL approach lie in the practice domain and lack critical discussion of issues of methodological and conceptual rigour, scenario planning has been subject to academic critique, as discussed in the next section.

5.2 Critique of scenario planning as a practitioner 'art'

The lack of a theoretical underpinning has meant that the basic IL approach to scenario planning has been subject to critique over the years, with various writers describing it as a 'practitioner tool' (Hodgkinson, 2001; Hodgkinson and Sparrow, 2002), and as an 'imperfect tool' (e.g. Hamel 2000; Hyde 1999; Mintzberg et al. 1998; Porter 1985). Scenario narratives have been considered as mere speculations, dealing with matters of opinion rather than of fact. Mintzberg (1994. p. 248) postulated that scenario analysis offered a scattergun approach to exploring potential futures where, "by speculating upon a variety (of futures), you might just hit upon the right one".

In their review of extant literature on the IL approach, Wright, Bradfield and Cairns (2013) questioned the degree to which the standard method challenged conventional thinking, reframed perceptions, and promoted change in the mindsets of managers within organisations. They argued that the process of envisioning a sequence of possible events within a scenario narrative will likely prompt participants to attach greater probability to their likely occurrence than would be implied by the normative probability computed for the intersection of these individually-evaluated events. Tversky and Kahneman (1983) identified this bias, caused by the mental operation of the 'simulation heuristic'. As a result, the act of constructing scenarios may, in itself produce increased, but inappropriate, confidence in the likelihood of any single scenario unfolding as reality. However, it must be noted that the use of multiple scenarios provides plausible, but *different*, chains of causality.

In addition, the basic IL method leaves several key aspects of strategic decision making to informal or holistic consideration - usually options are evaluated against the constructed set of scenarios in a simple Way, such as judgmentally allocating a number of "ticks" or "crosses" as a option/scenario performance measure. Notably, trade-offs between multiple objectives are not addressed and the relative power and potential future behaviour of stakeholders as they experience the unfolding of events within a particular scenario are not considered. Additionally, in the basic Il scenario development process, itself, there is no design element to mitigate the possible effects of status and power differences between participants. For example, relatively junior participants may be reluctant to advance opinions that are likely to be unpopular with senior managers. Also, importantly, the basic IL method does not address issues to do with the receptiveness of the organization or

workshop participants to the intervention. Further, as a time-consuming process, it does not address possible time constraints of workshop participants.

Thus in returning to the six attributes of methods for dealing with wicked problems identified earlier, we note that the basic IL approach exhibits – but, arguably, does not fully satisfy - the the six ideal attributes of a method designed to tackle wicked problems. In particular it is deficient in achieving attribute one (sound theoretical underpinning) and six (articulated action, responsibility, implications and impact). The following section explores recent augmentations to the basic IL approach and considers the extent to which they address these two major gaps and further satisfy the attainment of attributes two, three, four and five.

6.0 Augmentations of the IL scenario process: contributions to wicked problem resolution – theory and practice

6.1 Development of theoretical underpinnings

Researchers studying the IL scenario process have shown that it can be underpinned by theories both of how individuals confront uncertainty and how group processes integrate and mould individual perceptions. At the individual level Simon (e.g ., see Prietula and Simon, 1989) has discussed how experts are able to recognise familiar elements in new situations but Kahneman, (2011) has also shown that, when an expert's experience is not relevant in a particular situation, they may make erroneous judgments without being aware of this. In particular, they may resort to simplified mental strategies, or heuristics. These heuristics are likely to lead to biases when judgments about probabilities are required. Other researchers (e.g., Gigerenzer, 1994) have argued that the use of probabilities is inappropriate where unique non-repeated events are concerned. In particular, Shackle (1949) argued that individual decision makers cannot have access to exhaustive list of possible future states of the world or the knowledge to attach probabilities to these states (see also: Basili, and Zappia, 2009).

As an alternative, Shackle developed his Potential Surprise Theory (PST) . Derbyshire (2017) has recently demonstrated that PST contains an axiom base that can be used to underpin normative applications of the IL scenario development method. A key foundation is that PST is based on the plausibility of future events rather than probability. A second foundation of PST is that the future is seen as to-be-imagined and is thus judgmentally-based. In PST, the decision maker chooses between strategies in terms of; (i) expected potential gains and losses, and (ii) the decision maker's degree of disbelief (i.e., the implausibility) of a particular outcome. Crucially, unlike belief in a particular outcome, one's disbelief in several currently-considered future outcomes is not necessarily affected in any way by consideration of, and disbelief in, a newly-considered future outcome. Moreover, the IL approach to scenario analysis and PST focus on plausible extreme outcomes. Derbyshire demonstrates

that the reasoning between Shackle's rejection of probability provides strong theoretical support for IL-based scenario analysis as a normative decision-aiding – given that each of the axioms of PST are accepted as reasonable by the decision maker.

Shackle's reference to imagined futures raises the question of how people view such prospective worlds. In PST a scenario is an overall outcome rather than a developing sequence of events as in Il scenario planning. However, narrative theory proposes that narrative is a fundamental human strategy for making sense of the elements of our experience such as changes and time (Herman et al. 2010). Narratives make issues concrete allowing decision makers to visualize them and their potential implications. According to Gabriel (2000), rather than merely recounting events, they can enhance and enrich them, endowing them with meaning. The generation of multiple scenarios in scenario planning relates to Boje's 'antenarrative' theory (Boje, 2001). Here an antenarrative is defined as "a fragmented, non-linear, incoherent, collective, unplotted, and pre-narrative speculation". From this fragmentation and ambiguity multiple narratives, and hence multiple, scenarios can emerge (Cairns et al., 2017).

Theories such as PST relate to individual decision making but scenario planning is usually applied in a social context. Social constructionism posits that people develop shared assumptions of reality through social processes that involve jointly constructed understandings of the world. In this process, individuals create mental models to make sense of their experiences of the world and use language to share these models and to turns them into concrete perceptions of reality (Leeds-Hurwitz, 2009). Kolb (1983) has applied his theory of individual learning to these social processes postulating that learning will be enhanced when diverse decision making groups involve individuals possessing the skills in his 'learning loop': the ability to form theories, the ability to assess the implications of theories in new situations, and the ability to recall concrete experiences and reflect on them so that discrepancies between out mental models and reality are revealed (van der Heijden, 1996).

Cairns et al. (2010) have used the term 'Critical Scenario Method' to refer to an approach which interrogates scenarios from the standpoints of different stakeholders (see section 6.3.2). This is underpinned by Flyvberg's modern version of Aristostle's concept of *phronēsis*, referred to earlier. According to Flybberg, (Flyvberg, 2003) the principal task for phronetic research is to clarify values, interests, and power relations as a basis for practical action. Questions addressed in this process include: (1) who gains and who loses, and by which mechanisms of power and (2) what, if anything, should we (including all stakeholders where possible) do about it? This is achieved by developing in-depth narratives of how power works and with what consequences, and to suggest how power might be changed and work with other consequences.

In summary, PST now provides a theoretical axiom base for IL scenario planning and so promotes IL to be a competitor to decision analysis, whilst the other theoretical underpinnings that

have been outlined, such as narrative thinking, learning from experience, and phronetic research, provide more general support to underpin components of the IL approach in practice.Other theoretical foundations for scenario planning can be found in the work of Chermack (2004) and in systems theory.

6.2 Making sense of complexity: structured decomposition of causality

A cornerstone of rigorous scenario analysis is an acceptance of 'causal pluralism' (cf. Goodier et al., 2010), the origins of which can be traced back to Aristotle (cf. Derbyshire and Wright, 2017) through the lineage of Nietzsche (1885/1968) and his rejection of any single 'logic' of causality. For Nietzsche, causal linkages are matters of explanatory convenience for the purposes of intelligibility. As such, in exploring causal linkages in scenario analysis different understandings of causality that exist, say, between an accountant and an engineer must be made overt and addressed. Derbyshire and Wright (2017) have argued that the causality analysis at the heart of the IL method can be enhanced by applying the structured decomposition of cause that is the essence of Aristotle's very early distinctions between different types of cause. He differentiated material cause, formal cause and final cause from efficient cause and we explain these nuances next.

Efficient Cause is the type of causation in which some earlier event precipitates and brings about another event occurring later in time, in a chronological sequence of cause-and-effect. Identification of this type of 'general' cause is the focus of the basic IL scenario development method, above.

Material Cause focusses on the 'material' from which any object is made. Water is normally seen as a liquid, but at lower temperature it becomes ice – illustrating a material step-change. The search for material cause involves seeking out the causes of a step-change transformation. Such step-changes are, of course, important considerations for the logic of scenario generation.

Formal Cause directs focus to the formal structures that facilitate or impede action. For example, strategic plans can be viewed as the formal cause of an organization's activities. Laws and regulations can be seen as impeding or facilitating different types of organizational action. MacKay and Tambeau (2013) focused their conceptual analysis on the underlying basis of scenario construction and identify enduring social structures – including cultural and economic systems that are governed by rules and resources – as the major determinants of human actions. In so doing, they integrated 'structuration theory' with scenario method. Human actions are seen here as both constrained and facilitated by existing social and economic structures, and so they posit that interactions between human actions and such structures are pivotal in understanding the way in which the future might unfold.

Final Cause focusses on the motivations of self-interested individuals, groups and organizations who have power to take action within an unfolding future. As we have seen, consideration of power and the powerful is not part of the basic IL scenario development methodology.

Derbyshire and Wright (2017) show that interaction of the different types of cause can prevent particular causes from having an intended effect, and that a detailed decomposition and analysis of the interplay between the forces of efficient cause, material cause, formal cause, and final cause is necessary to provide a comprehensive understanding of the plausible unfolding of future states of the world. By making explicit the four different types of causes, and adapting the IL process specifically to uncover them, there is a greater likelihood of the full range of important causes being uncovered (Derbyshire and Wright, 2017).

6.3 Enhancing participative inquiry: addressing the scenario team participants' cognitive styles and modelling the full stakeholder constituency

6.3.1 Addressing individual participants' cognitive styles

The popular literature on the use of scenario technique mostly reports only on success stories of successful interventions. The practitioner writers are, understandably, less likely to report failure. As such, the extant literature has been less than helpful in generating evidence for guidelines on best practice in facilitating group-based involvement in strategic thinking. Recently, however, Franco et al. (2013) focused on the individuals who are the participants in scenario workshops. Using knowledge of the psychology of individual difference, they conceptualised and analysed workshop activity that is linked to individuals' modes of information gathering and evaluation. These authors contend that the mix of such 'cognitive styles' within the participants at a particular scenario workshop will determine the efficiency of the overall team in engaging with particular components of a scenario development process – such as reducing and selecting the key uncertainty factors and fleshing-out the detail of the scenario storylines. If the cognitive styles of workshop participants cannot be pre-selected, these authors provide guidelines for the successful facilitation of varied group memberships. Hodgkinson and Healy (2008) provided guidelines based on a different conceptualisation of pertinent individual differences. Neither conceptualisation has been evaluated empirically, to date.

6.3.2 Modelling Stakeholder behaviour

In critical scenario method (CSM) (Cairns et al., 2010) there is specific consideration of the impacts of the different scenario storylines on the full range of stakeholders, including those that are remote, often excluded and future generations. Initial consideration of the full range of stakeholders involves eliciting a list of all those individuals and organizations who might either affect or be affected by the

unfolding of the focal issue of the scenario project. It is important to surface as many separate stakeholders as possible, not just broad categories. For example, initial stakeholder identification by participants will normally include 'media', 'politicians', and the like. However, discussion with them will clarify that the group 'media' has many constituents, from national television to local newspapers and, in this age, social media platforms. Each has its own degree of interest in the issue to hand and its level of power to impact the unfolding of its future.

Identifying the stakeholders leads into consideration of how they will individually affect or be affected by a particular, unfolding scenario. Factors of 'interest' and 'power' underpin stakeholder analysis and form the axes for the resultant matrix (see Wright and Cairns, 2011, pp. 92-93 for the format and dynamics of stakeholder mapping). Cairns , Goodwin and Wright (2016) have extended these ideas and proposed a formal method, based on multiattribute decision analysis, to gain insights into the likely future actions of stakeholders under different scenarios as they seek to achieve multiple objectives.

From experience, we have found that participants will often equate power with interest – for example, assuming that the Prime Minister will have an immediate interest in some regional matter, rather than being fully focused on the bigger issue of the day, such as economic turmoil at a global level. Research into the effectiveness of how people engage with understanding others has highlighted that the adoption of 'role-playing' will result in consistently better decisions than will mere 'role-thinking' (Green and Armstrong, 2011). This has been found to be the case even where the decision makers have no direct experience of interaction with and little knowledge of the life-world of those that they are playing. Cairns and Wright (2018) detail how role-playing can be incorporated into the basic IL scenario development method.

6.4 Presenting challenge to current mindsets

6.4.1 Augmenting group process

Rather than having team members working cohesively on the scenario process, there are two methods that introduce explicit challenge to the in-development scenario storylines by participants. Schweiger, Sandberg, & Ragan (1986) discuss these approaches for introducing conflict and debate through role-play and splitting the main group into two or more sub-groups. The adoption of a 'devil's advocacy' approach involves one sub-group at a time putting forward a proposed decision or a strategy option. Another sub-group plays the role of devil's advocate, critically challenging and probing the first sub-group's proposal. In 'dialectical inquiry', each sub-group develops its own decision or strategy options, and all participants then come together to debate the range of assumptions and recommendations that relate to a particular issue. Both methods encourage the full group to; (i) generate alternative options for decisions and strategies, and (ii) minimise any tendency to 'groupthink' and an early agreement on one option, without consideration of others. Formalising these

approaches can overcome tendencies for individuals to be reticent about voicing criticism to preserve the harmony of the group. Research has shown that both methods will lead to development of a high-level of understanding of the reasoning underpinning the final group decision amongst group members.

Schweiger, Sandberg, & Rechner (1989) tested the use of both approaches to inducing conflict, comparing them to a non-adversarial approach to decision making, in which group discussion was used, with the aim of achieving consensus among members. Using a questionnaire to gather ratings from group participants, they found that both conflict-based approaches were rated higher, both in terms of producing better outcomes and in prompting more effective questioning of assumptions. While it is thereby shown that formalizing and legitimizing conflict generates higher-ranked perceptions of the quality of the final outcome of group decision making, it must be considered that – if such conflict and role-play is not sensitively managed – the impact might be to negatively affect the group's ability to work together harmoniously in future.

In practice, scenario development sometimes involves a scenario team composed of representatives from multiple agencies – i.e., the scenario team is initially formed from a heterogeneous constituency. In the more usual scenario development activity, conducted within a single organization, the basic IL process results in the initial development of four skeleton scenarios that are then each fleshed-out by one of four sub-groups. However, since differences in world-views between these sub-groups are likely to be small, we recommend that once a particular scenario is fully developed it should then be given an adversarial critique by one or more of the other subgroups. In this way, also, the systematic introduction of conflict and challenge is likely to enhance the quality of the finally-developed scenarios. Cairns and Wright (2018) detail how group-based challenge can be incorporated into the basic IL scenario development process. Also, in supporting strategy development, one approach that has adopted a dialectical stance is SAST - Strategic Assumptions Surfacing and Testing (Mason & Mitroff, 1979) a method for surfacing and challenging assumptions made by decision makers.

6.4.2 Improving weak signal and blind spot detection

Horizon scanning, as an organizational activity, attempts to identify and focus on 'early warning signals' of important change in the business environment – the identification of 'flags' or important signals amongst noise. Ramirez et al. (2013) used case examples from the companies Nokia and Statoil to document the relationship between scenario development and the monitoring of early warning signals in the business environment. In their case analysis, these authors explored the degree of synergy between these two activities and argued that the combination of activities can create potential competitive advantage by providing a continuous strategic service to top management, in contrast to the discontinuity often inherent in a sequence of scenario exercises.

In another study, Schoemaker et al. (2013) also considered the issue of how scenario development can be used as a basis for recognising and responding to 'weak signals' in the external environment. These authors argued that the contemporary, highly networked, organization has extensive points of contact with the external world and how, while expanding the opportunities for recognition of emergent opportunities and threats, this also presents the threat itself of leaving the organization unable to spot useful signals amongst the 'avalanche of data'. They outlined an approach to seeking such useful signals amongst background noise based upon the adoption of a 'strategic radar system' and they illustrated the approach with a brief case study of a large government agency.

It is important to note that each developed scenario represents a single set of antecedent (driving) forces, each leading to a distinct, scenario end-state outcome via sequences of cause-and-effect relationships. Recall that each 'resolved' cause (i.e., each driving force –whether a pre-determined element or an uncertainty resolved as a particular outcome) precipitates another outcome in the causal chain until the sequenced outcome of the chain is realised. In this 'efficient cause' perspective on causality, knowledge of the chain events' initial causes implies knowledge of the chain's ultimate outcome and so, logically, identification of an 'early warning' or 'weak signal' is possible (Derbyshire and Wright, 2014; Ramirez et al., 2013; Schoemaker et al., 2013).

Here, an 'early warning' would be the occurrence of a particular outcome at an early point in the pre-identified, sequenced chain of driving force. As a result, application of the basic IL scenario development methodology gives the *misimpression* that all that is necessary to avoid an undesirable future is to be alert to the start of an occurrence of a particular sequence of events and, upon noticing such an unfolding, to take action to avoid the undesirable outcome described by the scenario. However, in Derbyshire and Wright's (2017) analysis, not only are there multiple possible futures, there are also *multiple possible causal paths to each future*. Each future end-state has multiple possible sets of antecedent causes. Importantly, this consideration, that there may be multiple possible paths to a single future, is unrecognised within the basic IL approach to scenario development – and has no emphasis in all the other approaches to scenario development (Bradfield et al., 2005).

Crucially, it follows that, since there are multiple possible paths to any particular future, activities designed to sensitise an organization to indications that a particular causal path of events beginning to occur – by so-called 'horizon-scanning' functional units – are misplaced. Uncertainty associated with the future is much more complex than implied by particular scenarios – or even a set of multiple scenarios. As such, extant methods for identifying weak signals will lead to either: (i) unfocussed, or (ii) focussed but naive assessment of possible important weak signals or flags – since their identification will either be happenstance or limited to those prompted by already-developed scenarios. The most important scenarios for an organization are often the ones where an organization's objectives are met in the extreme – either negatively or positively – and the basic IL method of scenario development may not produce such plausible but extreme scenarios. Also, any particular scenario that is developed may not sensitise a manager to the true sequence of causality that

unfolds. As such, the basic IL scenario development method is of weak utility to aid the prior identification of all important but 'weak' signals.

Fortunately, the 'backwards logic method' (BLM) for scenario development (Wright and Goodwin, 2009) provides an answer to this major issue (for more detail on the combination of the BLM with horizon scanning see Rowe et al., 2017). First, note that the initial causal elements of extreme scenarios are identified in the BLM development process and that these initial causal 'triggers', now identified, can next be easily adopted as important, focal 'weak signals' that should be carefully monitored in a subsequent, on-going horizon scanning process.

An additional precautionary measure is to ensure that a full range of weak signals are being monitored in any organizationally-based horizon scanning activity. Meissner et al (2017) define a process for identifying blind spots and weak signals in an horizon scanning activity in their so-called '360^0 stakeholder feedback' technique. Here, members of an organization and, importantly, opinion leaders who are also knowledgeable about the focal organization and its environment but are affiliated to external organizations (that are likely to have different perspectives) are recruited. They are then asked to identify and describe factors that may influence the future development of the focal organization – with reference to the PESTEL set of dimensions. By their method, a 'blind spot' exists within the organization if the internal experts' ratings of both the impact and uncertainty of a particular factor are significantly lower than those of the external experts. Also, by their method, a 'weak signal' exists if a particular factor was mentioned by few people in a first round of evaluations but was then rated of high impact and high uncertainty in a second round of evaluations by most of the participants.

6.5 Acknowledging uncertainty

This attribute is, we contend, already well-addressed in the basic IL scenario development method, outlined earlier. Our discussions in Sections 6.2, 6.3 and 6.4 indicate how the recent augmentations to the basic method further satisfy achievement of this attribute.

6.6 Informing decision making and subsequent action

6.6.1 Formal analysis of multiple objectives

A distinction needs to be made between papers in the literature which regard scenarios as options that need to be ranked in order of preference (e.g. Browne et al., 2010, Ribeiro et al. 2013) and those that discuss the problem of identifying the 'best' strategy across a range of scenarios that may prevail. Only the latter case will be discussed here. The absence in scenario planning of formal methods to support strategic decisions involving multiple objectives was explored by Goodwin and Wright (2001). They suggested that multi-attribute decision analysis methods based on the simple multi-attribute rating technique (SMART) could be combined with scenario methods to compare the

performance of alternative strategies across both the objectives and the scenarios. Approaches like SMART bring the benefits of decomposition to the process and also allow for the formal structuring of objectives hierarchies (Montibeller and Franco, 2011) and sensitivity analysis. Linares (2002) used a similar approach, but the strategies were evaluated using a combination of the Analytic Hierarchy process (AHP) and goal programming. Durbach and Stewart (2003) also demonstrate how goal programming can be used in combination with scenario planning.

In practice, a balance needs to be struck between the advantages of relative simple methods, which are likely to be more palatable and transparent to decision makers, and the benefits of more complex methods that are both theoretically sound and provide a more accurate representation of the decision problem. While the use of SMART in this context, as proposed by Goodwin and Wright, offers relative simplicity and transparency it assumed that the same weights could be attached to the objectives in all scenarios. This implies that the relative desirability of swings from the worst to the best performances on the different objectives is the same, regardless of the scenario. This proved to be problematical in applications of Goodwin and Wright's method by Montibeller et al. (2006) and they suggested improvements which were subsequently used in three public sector applications (Ram and Montibeller, 2013). However, the number of judgments that need to be elicited from decision makers can be large, given the combinations of objectives, strategies and scenarios and attaching different weights can add considerably to this burden. Schroeder and Lambert (2011) suggest a method for obtaining scenario-specific weights that reduces the size of the elicitation task. This involves determining a set of weights for a 'base scenario' and then reweighting criteria for other scenarios based on whether they require a major or minor increase or decrease from those elicited for the base scenario. In an alternative attempt to reduce the demands placed on decision makers, Wright and Cairns (2011) suggested that the interval-scale ratings that are used in SMART to reflect the performance of each strategy on a given objective can be replaced by simple rankings.

The methods based on SMART produce a table showing an aggregate score for each strategic option in each scenario. While decision makers are free to examine this table and choose options based, for example, on their attitude to risk there can be an absence of formal guidance, at this stage. The common suggestion is that the strategy that has the most robust performance across scenarios should be chosen, but as argued earlier, there are problems with the definition of robustness and questions about its desirability in some cases (Stewart et al., 2013). Ram and Montibeller (2013) displayed the regret associated with each option across the scenarios (i.e. the under-performance of an option in a given scenario relative to the best performing option in that scenario) to provide guidance to their decision makers on robustness in three case studies. Other authors imply that robustness is associated with a relative lack of variation of aggregate scores across scenarios, but Stewart et al. (2013) argue that this may obscure the benefits of strategic options where: 'equity between criteria are dominant (e.g. where the criteria are linked to the interests of different stakeholders)'. Such conditions might apply where there is a danger that a chosen strategy will lead to the best outcome for one

stakeholder but the worst for another. A strategy where both simultaneously obtain either their best or their worst outcomes might be preferable (we deal with the issue of taking into account the diverse interests of stakeholders later on). Stewart et al. propose that each scenario-criterion combination should be regarded as a metacriterion. Alternative strategies should be evaluated against these metacriteria in the same way that options are evaluated against ordinary criteria in conventional multi-attribute decision analysis, albeit with some form of hierarchical elicitation to make the task tractable, when there are a large number of metacriteria.

6.6.2 Use of scenario orientation

There are a multitude of tasks and activities involved in a scenario planning process. As a result, projects are often conducted across multiple workshops; some workshops run over consecutive days, but others are scheduled over a period of weeks or months with longer gaps in between. Where a scenario project is conducted across a series of workshops, there may be a delay or gap between the development of the scenarios and their subsequent use to support strategy development. Additionally, there is no guarantee of continuity of participation spanning the phases of scenario development and use. In some settings, this may be unavoidable due to competing commitments; in others it may have been intentional, such as when the scenarios are intended for wider dissemination. Where there is a time delay or changes in the personnel involved between scenario development and use, the detailed understanding of the scenarios and the motivation for their development may be missing, forgotten or not be equally understood by all participants. All this leads to a decrement in both decision making and subsequent action.

Bowman (2016) argues that a key benefit of scenario planning 'mindset change' only comes from participation "...in the episodic and continuous flow of sensemaking and storytelling." (p 91); i.e. from engagement within and across workshops. Where this is not practically possible, or where there is a break in the flow of workshops, a process of scenario orientation (O'Brien and Meadows, 2013) can be a crucial phase in bringing newcomers on board, and ensuring that the group using the scenarios are familiar with them. As the name suggests, orientation is a process of familiarisation that involves understanding the nature of the scenarios in some detail; such a process not only focuses on the product, the scenario stories, but also entails reviewing relevant aspects of the process through which they were generated. Well-written and presented scenario narratives act as sense-giving artefacts (Bowman, 2016) which can facilitate participant engagement and buy-in during an orientation phase; where scenarios are used within a public setting, they may serve to facilitate interaction and engagement of relevant stakeholder groups (Bowman et al, 2013).

Where bringing together all participants in a face to face workshop is not practical or possible, the use of online platforms may offer an alternative setting; this forms an emerging area of research in the scenario literature. Raford (2015) reflects on experiences from five case studies using different online platforms to support scenario planning exercises; he contrasts these experiences with

a face-to-face scenario exercise. Four key findings are reported: online approaches offer the potential to increase the volume and diversity of participation; an increase in the amount and speed of data produced of volume produced; varied approaches were used to cluster and process factors; and improvements were observed in participant socialisation and interaction.

6.6.3 Addressing senior decision makers' time constraints

A major problem that has been identified in scenario projects is the absence of senior decision and policy makers from the process (cf. Cairns et al., 2013), and how to engage with such 'time poor' individuals (Pincombe et al., 2013). One approach that has been proposed and discussed for engaging key stakeholders who are unable to commit to full engagement with a scenario development programme involves the use of Delphi inquiry (for explication of Delphi method, see Rowe and Wright, 2001). Delphi inquiry enables expert opinions regarding understandings of key uncertainties and their potential outturns to be sought in an asynchronous process, where individuals can choose when to participate subject to a common deadline. These opinions are shared anonymously amongst the panel members, with both quantitative rankings and explanatory justifications and, on the basis of this sharing, these are revised by individuals and further shared anonymously over two or more rounds. Anonymity has the advantage that participants will not feel constrained in expressing their honest views because of the presence of more senior managers in the process. Collated data will show degrees of convergence or divergence in the individual views, change over the rounds, and will summarise the means and ranges for each factor, along with the explanatory narratives. Delphi method enables time-poor individuals to collaborate but without having to do so in real time.

Delphi inquiry has been used to provide early input to the determination of the driving forces that will shape scenarios (Pincombe et al., 2013). Cairns et al. (2016) discuss a case of 'limited success' in a project that addresses the complex and ambiguous issue of 'regional regeneration', with multiple organizational stakeholders, having diverse priorities and cultures, and fragmented both in terms of time and of geography. Having employed Delphi inquiry at the end of the project to gain responses to issues highlighted in all-encompassing regional scenario outlines developed by an academic research team, they posit that the approach might more effectively be used to enable sub-sets of the full project team with similar disciplinary interests and specific project priorities to engage at the outset. Here, decision makers might share ideas and perceptions and set a common foundation for development of more focused scenarios around their field of common interest. These scenarios might still be written by others, where time is a rare commodity, or they may prove more attractive for participation in the development process due to their immediate relevance to the individuals involved. For example, in relation to regional regeneration, local industry executives, public sector agency directors or educational leaders might focus on the potential contribution of their sector, and the opportunities and obstacles presented by external driving forces. They could then take their sector-specific analyses and focussed scenarios back into the full forum of regional regeneration debate. This

approach might overcome what was seen to be a lack of commitment and focus by a divergent body of stakeholders.

6.6.4 Facilitating translation into action and impact

To move beyond scenario storyline development, and to give meaning to the ubiquitous – but frequently misrepresentational term – 'scenario *planning'*, there is clearly a need for demonstrable actions designed to respond to each scenario narrative. Planning must be undertaken to eliminate, minimise or build resilience in the face of worst-case futures, and to take advantage of best-case circumstances. If planning is to be shown to be a direct consequence of scenario analysis, the final stages of any project should illustrate a list of clearly articulated actions that are directly informed by the scenario narratives. If the scenario project has engaged appropriate senior decision makers, this list of actions should include allocation of responsibility for ownership and implementation by individual participants. However, Rickards et al., (2014) have highlighted the lack of linkage between scenario outcomes and decision making as the key factor in challenging the effectiveness of scenario programmes. Cairns et al. (2013) provide a case study of a project in which senior members of various organizations committed to a shared list of actions, and accepted individual responsibility to follow up. However, the study outlines how, months after the scenario workshop, there was little or no evidence of follow-up. The authors discuss how this lack of action could not be simply attributed to other pressures 'back at the office'. Rather, they point out that senior decision makers at the level of the project may not be the key policy makers at the highest level of decision making. As Bowman et al. (2013) point out, policy and strategy making are political (with a small 'p') processes and, as such, are subject to issues of trust, manoeuvring and the contradictions of short- and long-term goals.

The problem of determining and allocating responsibility for clearly articulated action is one of great complexity, particularly in multi-organizational projects. Cairns et al. (2017) posit that large and complex projects might usefully be broken down into sub-programmes, each involving participants with shared interests and values, exploring the range of their perceptions and interpretations initially through Delphi inquiry, before engaging them in a clearly focused 'exploratory' scenario exercise that is a discrete sub-set of the main project, and that can later inform an integrative 'challenge' scenario exercise by the most senior – and likely time-poor – policy makers. In this way, identification of actions and responsibility is distributed to those most appropriate at each stage, with a 'cascading up' of scenario analyses, outcomes and responses to these key individuals in a structured way.

7.0 Comparison of both basic and augmented IL scenario method with soft OR methods when addressing wicked problems

Table 2 compares the basic IL method and its augmentations with the soft OR methods against each of the six desirable attributes that were discussed earlier.

INSERT TABLE 2 ABOUT HERE

While scenario planning has emerged from practice, theoretical underpinnings for the method have been identified subsequently, as explained in section 6.1 . Of the soft OR methods, only SODA/Journey making has a clear foundation in theory. The origins of SCA have been described as "more empirical than theoretical… [reflecting] not so much idealized principles of decision making as an explicit recognition of some of the ways in which people who face complex decision problems in practice learn to cope with the dilemmas of their work, even if only at an intuitive level" (Friend, 2001, p116). The social reality implied by the social theory that underpins SSM is unclear and Houghton and Ledington (2002) have described the literature as being highly confused about this matter. As argued earlier, the absence of clear theoretical underpinnings may limit the extent to which a method will be accepted as soundly-based for application in practical contexts.

All of the methods involve structured iterative approaches and allow softer aspects of problems to be addressed. However the basic IL method is restrictive in that it neglects the decision making aspects of problems and the role of stakeholders – both in the formation of scenario teams and, more broadly, in their reactions to (and plight within) unfolding scenario storylines . Recent augmentations of the method have begun to address the decision making aspects of scenario thinking (see Section 6.6) but more research and practical method development is required so that decision makers are not overloaded with elicitation tasks (Montibeller et al., 2006) and the robustness of decision options across scenarios can be further clarified (Stewart et al., 2013).

With regards to stakeholders, a distinction needs to be made between modelling their behaviour and interests and directly involving them in the decision making process. All of the methods have the capacity to allow multiple stakeholders to participate in the process and for their different perspectives to be modelled, but only the IL method when combined with the Delphi method ensures that power and status differences are not influential in the process.

Both SSM and SODA/Journey making emphasise learning and have mechanisms that have the potential to challenge existing mind sets. The SCA, like hard decision analysis, has no explicit element that is designed to provide such challenges and the basic IL method may actually reinforce current views. However, the IL method may benefit from the challenges generated through dialectical enquiry and the involvement of remarkable people. There seems to be no reason, in principle, why such augmentations could not also be applied to the SCA. While the basic IL method can be associated with blind spots about potential changes in the environment and fails to recognise the

possibility of multiple paths leading to single future outcomes, recent augmentations, such as horizon scanning coupled with the backward logics method, should help to address these deficiencies.

SSM and SODA/Journey Making do not explicitly address uncertainty, though the latter method has some limited provision for handling it within cognitive maps. In contrast, uncertainty is the central consideration in both the SCA and IL scenario planning, though in SCA this may relate to current rather than future uncertainties. SCA has formal mechanisms that encourage participants to broaden their perception of uncertainty and hence increases their awareness of the extent of the uncertainty they are facing.

Finally, the methods vary in the extent to which they are likely to lead to the identification and implementation of specific strategies. SSM in its more recent form is primarily focussed on fostering learning and understanding rather than identifying and applying specific interventions (Houghton and Ledington, 2002). Neither SODA/Journey Making nor the basic IL method provide formal support for comparing the merits and demerits of alternative strategies. Only the SCA and scenario planning augmented with multiattribute decision analysis provide this. In all cases participation is likely to encourage a joint commitment to action, but only SODA/Journey Making emphasises this aspect with its focus on negotiation and achieving consensus. Of course, implementation is more likely if participants are receptive to the application of a method. The SCA is designed to achieve this receptiveness because it is intended to reflect the way that people make decisions in practice. The basic IL method has no formal element in its design that addresses the issue of receptiveness, though the narrative nature of its output is likely to accord with the way people naturally think about the world. However, breaking down the scenario planning exercise into sub programmes of people with shared interests and values allows actions and responsibilities to be distributed to those most appropriate, increasing the likelihood of implementation (see Section 6).

It can be seen that in many respect the methods have complementary strengths and limitations. For example, SSM is designed to increase participants' understand of wicked problems, but lacks formal consideration of uncertainty. The basic IL method emphasises future uncertainty but does not provide support for those who need to develop a strategy for dealing with it in complex problem situations. Similarly, the causal structure of cognitive maps can be useful in identifying the interaction of factors that can lead to alternative scenarios (Goodier et al., 2010). Mingers (2001) and Ormerod (2001) discuss how to apply such multimethodologies in practice.

This paper set out to investigate the potential of IL scenario approaches for exploring wicked problems as defined within the OR field. We identified six desirable attributes of methods designed to tackle wicked problems. Our paper introduced the basic IL scenario method and described recent augmentations to it. The basic and augmented IL scenario method were then compared against each of the six attributes, along with three of the classic soft OR approaches. Our paper demonstrates that both the classic three soft OR approaches and the basic IL scenario method, when used on their own, fail to satisfy all six of the attributes relevant to wicked problem resolution. It is through

augmentations and additions to the methodologies, within a multi-methodological framework, that the complete set of attributes can be satisfied. Importantly, in our analysis, only the augmented IL scenario method has an axiom-base to underpin its application in practice contexts. Further, the combination of IL with multi-attribute value analysis supplements and strengthens the axiom-based underpinning of the use of the IL scenario method as an aid to organisational decision making. Notably, of all the soft OR approaches that we have discussed, only the IL method deals explicitly with future uncertainty. In our view, the recently augmented IL scenario method now provides a well-founded soft alternative to the hard decision analysis approach of making decisions in the face of uncertainty. For this reason, it should now be welcomed by soft OR practitioners as a well-designed, future-focussed tool that has a specific place - together with Soft Systems Methodology, the Strategic Choice Approach, and SODA/Journey Making – within the broad soft OR toolkit. In addition further research could usefully explore the links between the IL scenario method and soft OR methods . For example, SSM considers the development of one virtual world, while within scenario planning, the concept of multiple alternative futures is important , suggesting that this may be useful to an SSM intervention.

Desirable attribute	SSM	SCA	METHODOLOGY SODA/ JOURNEY MAKING	INTUITIVE LOGICS SCENARIOS	
				Basic method	**Augmentations**
Sound theoretical foundation	Developed from practice. Interpretive stance but relation to social theory is not clear.	"Origins are empirical rather than intellectual" reflecting ways people handle complex decision problems.	Theory is clearly articulated. Interpretive stance and draws on Kelly's theory of personal constructs.	Practitioner driven -theory undeveloped	Theoretical underpinnings subsequently developed.
Involves structured decomposition to minimise reduction and exclusion	Structured iterative approach. Includes consideration of 'softer' issues. Adopts systems approach to embrace complexity.	Involves structured decomposition of uncertainty and choice process. Allows inclusion of 'softer' aspects.	Cognitive maps or oval maps facilitate problem structuring. 'Softer' aspects and stakeholder behaviour can be included. Merging individuals' maps broadens problem representation & may lead to expanded option set.	Structured decomposition of different types of causality, but decision making aspects neglected. No formal analysis of stakeholder behaviour.	Combination with multiattribute decision analysis allows formal comparison of strategic options. Stakeholder mapping allows behaviour of actors & power considerations to be incorporated. Decomposition of causality aids understanding of the unfolding of events.

Engages full stakeholder community	Explicitly considers different perceptions of stakeholders using CATWOE tool and seeks to understand their world views. Power and status differences of participants not explicitly addressed.	Ideally involves workshops of 6 to 8 people. Wider community can be consulted through workshop members' 'constituencies'. Power and status differences of participants not explicitly addressed.	Client is seen as small group: 3 to 10 people. Use of oval mapping can increase no. of participants & reduce analysis time. Map merging and workshops allow participation of different stakeholders. Key stakeholders identified though power -interest grids/star diagrams.	Workshops allow participation by multiple stakeholders. Nothing in process to mitigate status & power differences between participants.	Attention to individuals' cognitive styles may enhance efficiency of process. Delphi method allows participation of time constrained stakeholders and eliminates status differences. Online platforms and scenario orientation can widen participation. Critical Scenario method aids identification of all impacted stakeholders.
Challenges mind-sets	Emphasis on understanding & learning & interfacing of different world views may achieve this.	May lead to shared learning amongst decision makers but like 'hard' decision analysis, has no element explicitly designed to challenge mind sets.	Emphasis on understanding & learning. Reflection on individual maps, negotiations & merging of individuals' maps may achieve this.	No element explicitly designed to challenge mind sets. May even reinforce current mind sets. Possibility of multiple paths to single future	'Remarkable people', devil's advocacy, & dialectical enquiry may challenge mind sets. Horizon scanning, blind spot detection & backward logics

				outcomes unrecognised	method may alert people to potential future changes.
Acknowledges & responds to uncertainty	Not explicitly addressed	Addressing & responding to uncertainty is central to the approach, though emphasis may be on current rather than future uncertainties.	Binary events represented by concepts on map with contrasting poles. Maps may lead to identification of uncertainties. No formal method for addressing uncertainty.	Acknowledges uncertainty but simulation heuristic may lead to its underestimation.	The above augmentations should increase sensitivity to uncertainty.
Lead to actions, responsibility, implications & impact	Emphasis is on learning rather than intervention & problem solving.	Designed to identify appropriate courses of action. Workshop participation encourages joint commitment. Designed to reflect way decisions are made in practice which may enhance participants'	Emphasis is on negotiating consensus & hence commitment to action. No formal mechanism for identifying favoured options & facilitating implementation.	Receptiveness to intervention by organization or participants not addressed. No formal mechanism for identifying favoured options & facilitating implementation.	Break down of exercise into sub programmes of people with shared interests & values so that actions & responsibilities can be distributed to those most appropriate. Time-poor participants can be accommodated

	acceptance of it.	and the effects of a prolonged time-duration of a particular scenario intervention can be attenuated.

Table 2: Comparing approaches and how they address the six desirable attributes for dealing with wicked problems.

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