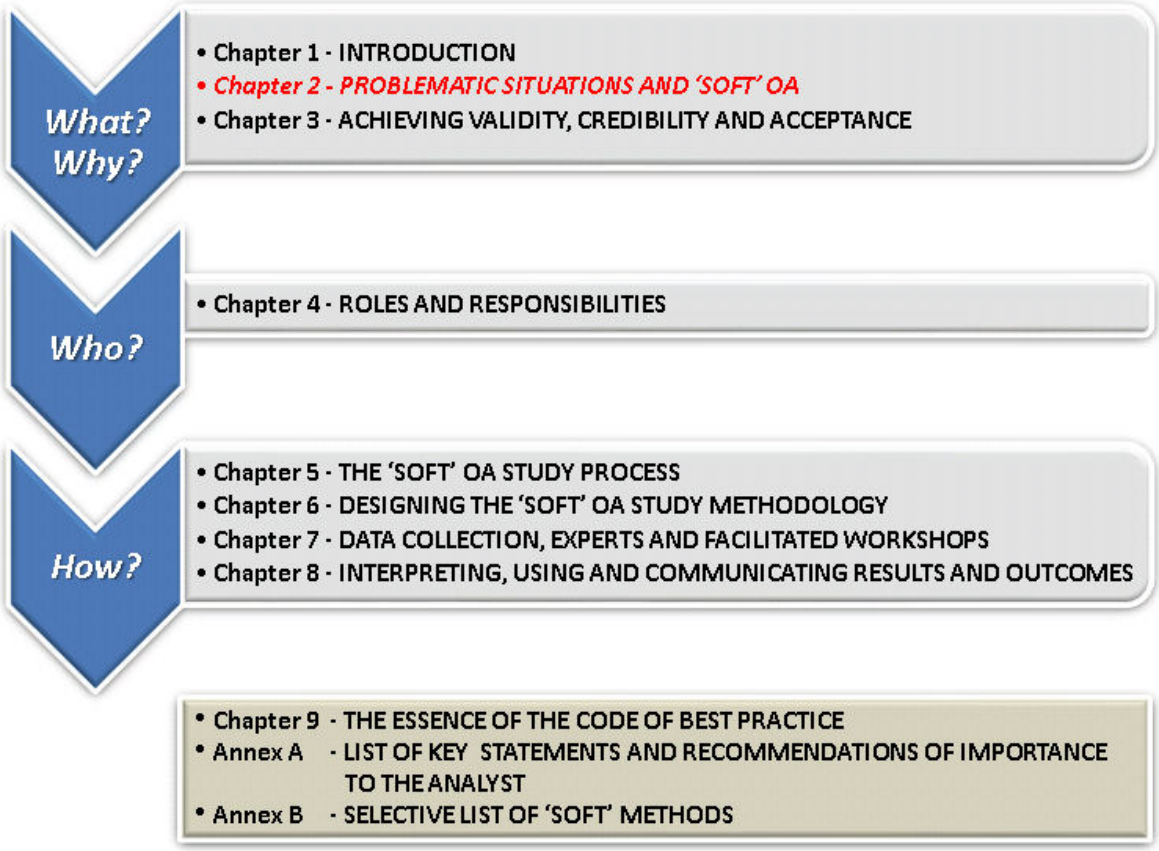
Chapter 2 – PROBLEMATIC SITUATIONS AND 'SOFT' OA



- Three types of a problematic situation can be distinguished: puzzle, problem (proper), mess. Each type is approached somewhat differently. 'Soft' OA tends to be more suitable for problems (proper) and messes.
- 'Hard' and 'soft' OA both support decisions regarding problematic situations. There are however numerous differences between them from a large number of perspectives, although in practice each perspective represents a spectrum.
- Uncertainty is one of the key phenomena that need to be addressed in a problematic situation as it characterises a problematic situation to a large extent.
- 'Soft' OA aims to structure problematic situations (with a focus on problems proper and messes), identify stakeholders and their interests and perceptions, include them in the study, use modelling primarily as a means to clarify issues and enhance communication but also to identify possible options for a most preferred way ahead in resolving the problematic situation.
- Messy problems cannot be fully resolved but should rather be managed.
- 'Soft' and 'hard' OA are in many respects complementary to one another; they are not competing OA approaches.

2.1 INTRODUCTION

This chapter introduces three types of a problematic situation that may be encountered. It then discusses the characteristics of 'hard' and 'soft' OA and points out similarities and differences. It focuses on the nature of data and models (and methods) and relates this to 'soft' and 'hard' OA. The chapter also discusses the phenomenon of uncertainty that to a large extent characterises the type of problematic situations addressed by OA (and specifically 'soft' OA in a defence context). This chapter ends by summarising why one would use 'soft' OA in a study.

2.2 PROBLEMATIC SITUATIONS

The term 'problem' has many meanings: it is used in this CoBP for any situation in which there is a perceived gap between its current state and its desired or required state, and which needs or seems to need a (re)solution involving some action, although it may often be unclear what (re)solution and what action are most appropriate. The term also has a specific meaning as one type of 'problematic situation' (see below).

For the purpose of the CoBP it is useful to distinguish between a few distinct problematic situations. The reason for this is that they usually require different approaches to address them. The literature suggests the following three problematic situation types summarised in Table 2-1 (ref. e.g. [1]):

- '*Puzzles*' – These are problematic situations where the issue is clear, what needs to be achieved is clear and the way in which this should be done (i.e. the model to be set up and the method to be applied) is also clear. Even in the case where these elements are not immediately clear, an agreement on their definition can be easily reached. Achieving a solution to a 'puzzle' may still be complicated but knowing how to build the model and which method to apply is a matter of education and expertise. The quality of the solution (e.g. its optimality) is usually testable.
- '*Problems*' – In this CoBP, problems have a more specific meaning and will therefore referred to as 'problem (proper)'. They denote situations where the issue may be more or less clear and structured and what needs to be achieved is (partially) clear as well. It is however not clear at the outset in what way a solution to a problem should be designed. Whereas the issue and the desired achievement may be readily agreed upon, achieving a solution is not a routine activity but will have to be negotiated depending on the views of the people (including analysts) involved and (often many) perspectives that are relevant. Therefore, it is not likely that an overall optimum solution will be produced. Rather a 'most preferred' (or 'satisficing'[1]) solution or set of solution options will be the result of the analysis, which will therefore require creativity in addition to education and expertise.
- '*Messes*' (or: '*Wicked Problems*')[2] – These are problematic (or even chaotic) situations that are ill-structured or do not seem to have any structure at all. The issues, and how they are interrelated, are not clear and considerable disagreement exists about them. Similarly, there is disagreement regarding what is to be achieved, who is to be involved and the steps that are to be taken towards some improvement or acceptable change of the situation. What is assumed, however, is that to some degree and with at least some people a sense of concern exists about the situation; something needs to be done, some decision must be taken in the end. What is also assumed is that it is possible to argue over the definition of the characteristics of the problematic situation. Messes are not solved, but managed [2]: coping with 'messes' requires considerable ingenuity and both analytical and social skills in addition to expertise with similar situations. No two 'messes' are the same.

[1] A decision or strategy or (re)solution is satisficing if it is good enough ('adequate'), but not necessarily optimal.

[2] Rittel and Webber formally introduced the term 'wicked problem' in [4], although they had first used it in the 1960s. Ackoff [5] introduced the term 'mess' or 'messy problem'. Although formally not identical, for practical purposes within this CoBP they denote a similar problematic situation type. This CoBP uses the term 'mess' or 'messy problem'.

Table 2-1: Main Characteristics of Puzzles, Problems and Messes.

	Puzzle	Problem	Mess
Description	Well-defined issue with a specific solution that can be worked out.	Well-defined issue, but with no single solution or approach.	Complex issue which is not well defined.
Formulation of the Issues	Agreed objectives achieved through logical analysis.	Agreeable after negotiation between clients and analysts, and input by other interested parties.	The lack of clarity and agreement of the issues themselves will make formulation disputed.
Typical Advice	Optimal solution.	Preferred option based on ranking.	Possible courses of action.
Validity of the Advice	Accepted after scrutiny of mathematics and calculations.	Even though the results are reached by agreed methods, the conclusions can be disputed thus leading to informed debate about the actions to take.	The advice will lead to an informed debate about the pros and cons of several possibilities for the way ahead.

The problems or problematic situations that 'soft' OA seeks to address are usually the messy problems, and to some extent problems proper, that present no obvious solutions. Problem framing is thus the activity of trying to understand a problematic situation so that meaningful action can be taken (ref. Chapter 6).

When approaching a messy problem, it is usually clear that there is (at least initially) no agreed problem definition. Different stakeholders will have legitimately different and perhaps even contradictory views of its nature. In this context, problems have to be seen as socially constructed [3]. This means that there cannot be a correct problem definition, merely many possible definitions that may be useful for facilitating action. Moreover, the stated problem may not be the real or full problem and the problem statement should therefore be explored.

A well-defined problem is helpful for conducting a study, but in many cases it may not be possible to agree on a problem definition. In order to get a useful answer, it helps if you know what the question is. At the same time, the socially constructed nature of problems means that getting a useful problem definition has to involve some kind of negotiation. Often in 'soft' OA, in order to frame a problem, a facilitated process is used. Many of the more well-established methods in 'soft' OA are focused on problem definition.

It has also been argued (Chapter 1) that 'soft' OA will be of value in decision-making situations where the inputs in terms of data and information are not readily or reliably available[3], the decision consequences cannot be easily foreseen, or where decision options may even be undefined and clear inputs non-existent. Also for this reason, 'soft' OA and therefore reliance on human judgement will most likely be of value when facing 'messes' and perhaps 'problems' as well. 'Hard' OA will most likely be of value with 'puzzles' and to a lesser degree with 'problems'.

In NATO a capability manager was asked to consider the future capabilities that might be needed for expeditionary operations. He took the NATO definition of Expeditionary Operations as his starting point, however he found it vague and all-encompassing and therefore not useful to direct or inform capability requirements analysis. Help was needed to bound and more clearly define expeditionary operations before a study of requirements could begin. Morphological analysis was used to identify common understanding about the key characteristics for expeditionary operations across various communities within NATO It was ideal as a tool to deal with the multi-dimensional and non-quantifiable nature of the problem. The study resulted in a more detailed description of expeditionary operations that could be used as the basis for further requirements work.

[3] This non-availability of data or its lack of reliability may also occur in a 'hard' OA study. In the latter, one would most likely resort to a parametric study.

Figure 2-1 illustrates[4] that puzzles represent clear-cut problematic situations where sufficient factual and complete information exists and little judgement is required. By contrast, messes represent complex problematic situations with incomplete and little factual information requiring substantial judgement. The potential usefulness of applying 'soft' OA increases when moving from the upper left corner of the diagram to its right lower corner.

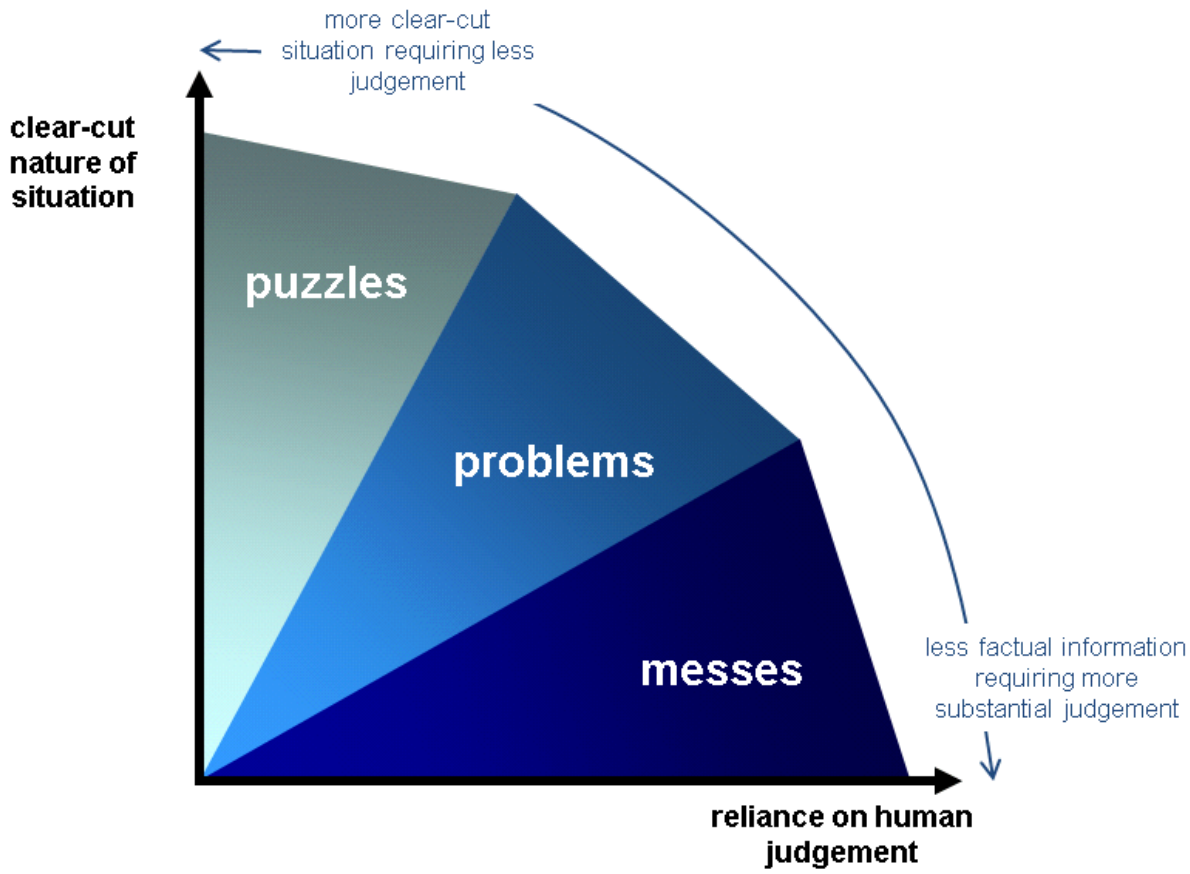


Figure 2-1: A Spectrum of Problematic Situations (Problem Types) and Their Clear-Cut Nature versus Reliance on Human Judgement.

2.3 ATTITUDES TOWARDS UNCERTAINTY

Defence problems almost always involve many kinds of uncertainty from a range of sources. Some of the uncertainty emanates from the characteristics of defence issues, and some of it is generally associated with the messy nature of problematic situations. For long-term defence issues, the main uncertainty is the development of the future operational environment, which determines the conditions within which a future capability is to be used. As new military capabilities require long lead-times, addressing this uncertainty is challenging. For near-term operational issues the key uncertainty is related to the intentions and capabilities of various actors in a complex conflict situation, and the character of the conflict in general.

Uncertainty in itself may call for 'soft' OA. In addition, messy problems show other forms of uncertainty. There is uncertainty regarding the objectives of action, closely connected to the uncertainty of intentions mentioned above. There is also uncertainty regarding the consequences of an action, emanating from a limited

[4] See [6] for an alternative way of illustrating this.

understanding of cause-effect relationships between factors of influence and unclear or debatable boundaries of problematic situations.

Fundamentally, there are two meanings of uncertainty which are related to its root causes: the *absence of knowledge* and the *inherent variability* of phenomena. In order to cope with uncertainty, three basic attitudes towards it may be distinguished, depicted in Figure 2-2. The corners of the triangle in Figure 2-2 represent basic 'primitive' attitudes, or types of bias, towards uncertainty:

- *Prediction* is the attitude that one should attempt to minimise uncertainty by trying to make as accurate predictions as possible.
- *Control* is the attitude that one should attempt to minimise uncertainty by seizing the initiative and taking control of the relevant bits of the environment.
- *Acceptance* is the attitude that one can never know what is going to happen, so there is no point in trying to predict or reduce uncertainty in any way.

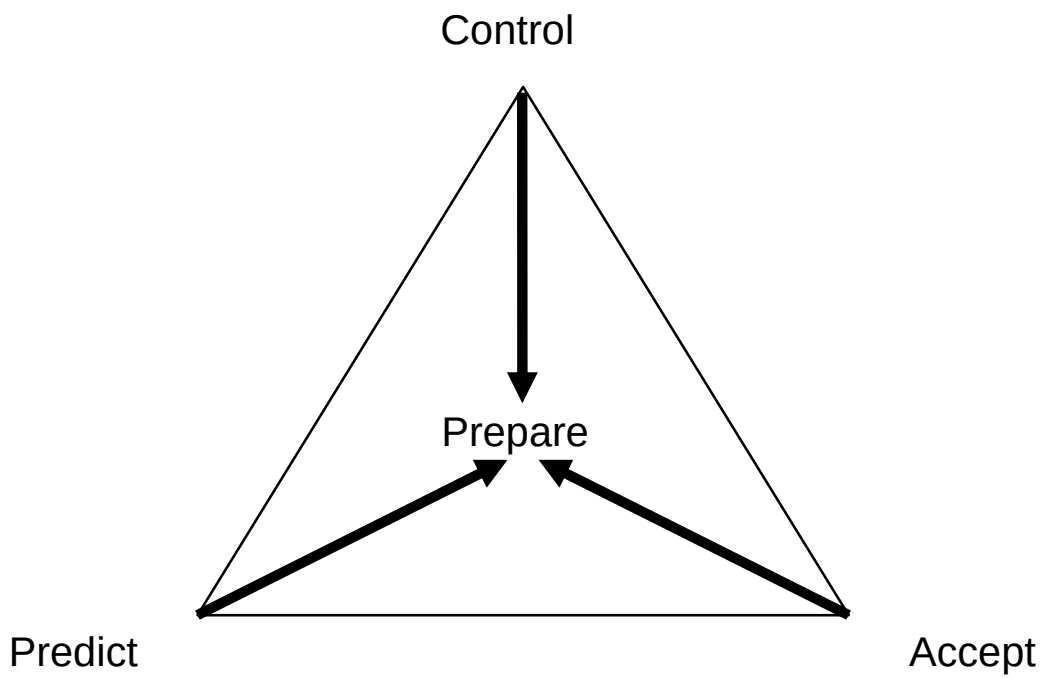


Figure 2-2: The So-Called Uncertainty Triangle, Denoting Basic Attitudes Towards Uncertainty (Extended from [7]).

Any of the three attitudes may lead to some form of *preparation.* This could range from focusing on those elements of uncertainty that can be predicted and design options accordingly, to designing, for example, a flexible, module-based response strategy in preparation of any contingency or challenge that might occur.

The idea behind the triangle is that a client should be aware of these attitudes, and that a proper mix of all three will be the most fruitful approach to preparing for uncertain events. For a messy problem, adopting only one of these attitudes is rarely sufficient.

It should be clear that it will not be sufficient to address uncertainty by merely varying a few of the parameters at the end of the study as part of a sensitivity analysis. The attitude towards uncertainty will shape the design of the study, specifically its problem framing stage and the stage where the *type* of options should be considered [7].

In subsequent chapters specific aspects of uncertainty will be discussed in more depth. For example, how the nature of the uncertainty affects the design of the study's ('soft') methodology is discussed in Chapter 6.

2.4 CHARACTERISTICS OF 'HARD' AND 'SOFT' OA

In the academic literature there has been some debate about the relationship between 'hard' and 'soft' OA. Some argue that they are two different ways of thinking, even two radically different paradigms[5] considering the differences in problematic situations for which they are most appropriate and the different methods they encompass. The CoBP adopts the view of others who argue that the two are complementary and can be used in series or in parallel, and even that 'hard' methods can be accommodated within a larger framework of 'soft' OA methods and vice versa. Even with 'puzzles' to be solved using some 'hard' OA technique there will always, at some level of the hierarchy of clients or at some stage of the study process, be different interpretations of data or results or validation findings. There will also be experts providing estimates based on judgement; and there will be group discussions in order to arrive at a consensus about, for example, the problem formulation to begin with. All these matters, also to be addressed in a 'hard' OA study, require approaches that are based on judgement and thus are related or even belong to the area of 'soft' OA. In addition, a 'soft' OA approach may turn to the use of some 'hard' method to solve a well-defined problem as part of a messy problematic situation[6]. This will be shown in the illustrative study scenario depicted in Figure 3-1 in Chapter 3.

In previous sections a large number of aspects of 'soft' and 'hard' OA have been addressed. They pertain to the nature of the problematic situation for which they are most suited, the purpose and outcome of a study, the people involved, etc. In the literature numerous taxonomies and tables can be found highlighting similarities and differences between the two types of OA. The most useful distinctions are summarised below in Table 2-2 instead of providing formal definitions of 'soft' and 'hard' OA. The descriptions tend to emphasise the differences and sometimes indicate extremes, but one should be aware that each aspect listed in Table 2-2 represents a spectrum of possibilities.

[5] A '*paradigm*' is a set of philosophical assumptions about what should be done and how (and the ethics of it) and about the nature of existing knowledge (and its validity) (based on [8]).

[6] As a further clarification: one of the methodologies that is often applied in a 'soft' OA is 'Soft Systems Methodology' [9]. The adjective 'soft' in SSM however refers to the way of dealing with problematic situations, not the nature of that situation itself. SSM can assist in addressing puzzles as well.

Table 2-2: Differences Between 'Hard' and 'Soft' OA as Extremes of a Spectrum (Based on e.g. [1], [3], [10]).

Aspects and Elements of the Study	'Hard' OA	'Soft' OA
Methodology	Based on generally accepted and theoretically grounded views of analysis. Predominantly factual and objective.	Based on thoroughly discussed arguments accepted by study participants. Predominantly interpretative, subjective, inductive. Proven value by experience.
Models	Shared representation of problematic part of the real world. Unambiguously linked to the study purpose and assumed to produce a problem solution. Utilise often (in addition to 'soft' representations) a formulaic representation of relationships between quantified concepts.	Representation of problematic part of the perceived world based on and shared by some or all study participants. Help understand study purpose and contribute to improving problem issues. Utilise the power of visualisation of concepts and their relationships often using well-chosen verbs and nouns.
Methods	Predominantly mathematics-based. Algorithmic.	Predominantly judgement-based, governed by guidelines and non-mathematical rules.
Data	Based on observer-independent measurement. Uncertainty treated stochastically.	Based usually on observer-dependent judgement. Uncertainty mostly treated qualitatively.
Study Outcomes	Based on rational, quantitative analysis. Based on clear results. Nature: 'solutions'. Search for the optimum. Repeatable.	Based on explorative, qualitative analysis. Based on insights and learning. Nature: 'ways forward'. Search for the requisite and accepted. Often not repeatable.
Study Purpose	Based on problem analysis. Clear at the outset and then taken as given.	Can become clear after problem analysis or even after one or more study stages.
Problematic Situation	Problematic situation is abstraction of the real world and can be delineated and engineered as a 'system' with its components. Usually short-term, operations-oriented. Single objective. Multiple objectives and perspectives can be modelled.	Problematic situation is often a mental construct and cannot easily or not at all delineated. Assembly of (partly) related 'concepts'. Usually long-term, strategy-oriented. Multiple objectives and perspectives exist, usually based on different stakeholder values that are difficult to reconcile.
Process – Study Stages	Can be designed ex-ante. Likely to be sequential.	Ex-ante design in general terms. Stages emerge as appropriate. Likely to be iterative.
Process – People Involved	Clients (and other stakeholders) provide input to problem analysis and model formulation. Power and emotion do not really matter. Analysts suggest and conduct the formal analysis, avoid biases, present solutions.	Clients (and other stakeholders) participate fully in process and can appear in a model-based representation of a problematic situation. Power and emotion matter. Analysts suggest and facilitate the process and any model usage, accommodate biases from different perspectives, engage clients in actively identifying options.

Although Table 2-2 suggests differences between the two approaches, the common denominator is the general posture of decision support.

The importance of Table 2-2 already arises at an initial stage of a study when the analyst has to negotiate the study approach with the client. Initial questioning based on the entries of that table will provide the analyst with information regarding for example (see Chapter 6 for further discussion):

- The nature of the problematic situation and the reason why it should be resolved;
- The people (or types of expertise) to be involved;
- The amount of effort required in getting a clear and shared picture among client and other stakeholders about what is to be achieved by the study, under what conditions an achievement is regarded as a success, and the nature of the information they can provide;
- The nature of the methodology/method to use (or even a combination of methodologies and methods), and the nature of data required;
- The study phasing; and
- The general attitude of the analyst and the client: a traditional expert mode (where the client can rely on the analyst to solve the problem), or a facilitated mode (where analyst and client/stakeholders work together to create satisficing options) [3].

Table 2-2 leads to four positive elements for a judgement-based approach over a purely quantitative one:

- The nature of the models involved lead to more of a conceptual approach, allowing more freedom in addressing the essence of the issue and thus avoiding, possibly unconsciously, adherence to the original paradigm;
- A creative use of uncertainty, allowing 'what if' considerations;
- A recognition of the need to consider all sides of the issue; and
- An appreciation of how to handle different viewpoints and belief systems.

This implied creativity leads to a divergent discovery phase where all aspects of the issue are discussed and explored. This is where completely new options or approaches may be discovered. This can be compared with the case for more structured issues (e.g. 'hard' OA) where there will be steady convergence from the start. The issue of divergence and convergence will be addressed again in Chapter 5 (Figures 5-8 and 5-9).

2.5 THE NATURE OF DATA AND MODELS IN 'SOFT' AND 'HARD' OA

It may be useful to focus on two prominent elements of an operational analysis: the data and the model and method for analysis. This discussion will not exactly define 'hard' and 'soft' OA more precisely than the previous section, which would be a daunting task, but may create a deeper understanding of the nature of both.

Figure 2-3 shows a scheme of different instances of the nature of data and models and methods and their combinations. In italics, some examples are offered to illustrate the general descriptions. Figure 2-3a shows the shaded parts of the scheme that are typical of 'hard' OA; Figure 2-3b shows the 'soft' OA parts. The combination of 'subjective' and 'quantitative' appears shaded in both. It depends on where one puts the emphasis: the elicitation of this type of data may use 'soft' methods, the result however is treated as input to a quantifiable, mathematical model, although some uncertainty may be involved. Even the degree of uncertainty, for example when expressed as a quantitative interval, may be used as numerical input to a mathematical model, although the elicitation of that interval is, again, essentially a judgement-based process[7]. All this illustrates that the distinction between 'hard' and 'soft' is not as sharply delineated as

[7] Another example would be the elicitation of input data for the Analytic Hierarchy Process (a decision-making methodology based on a hierarchy of multiple criteria, [11]) which requires a judgement-based elicitation process. However, the judgement data are processed by mathematical means to yield relative frequencies in the hierarchy.

suggested by the boxes in Figure 2-3; the boundaries between the boxes are rather blurred in practice and the arrows indicate that the scales are floating.

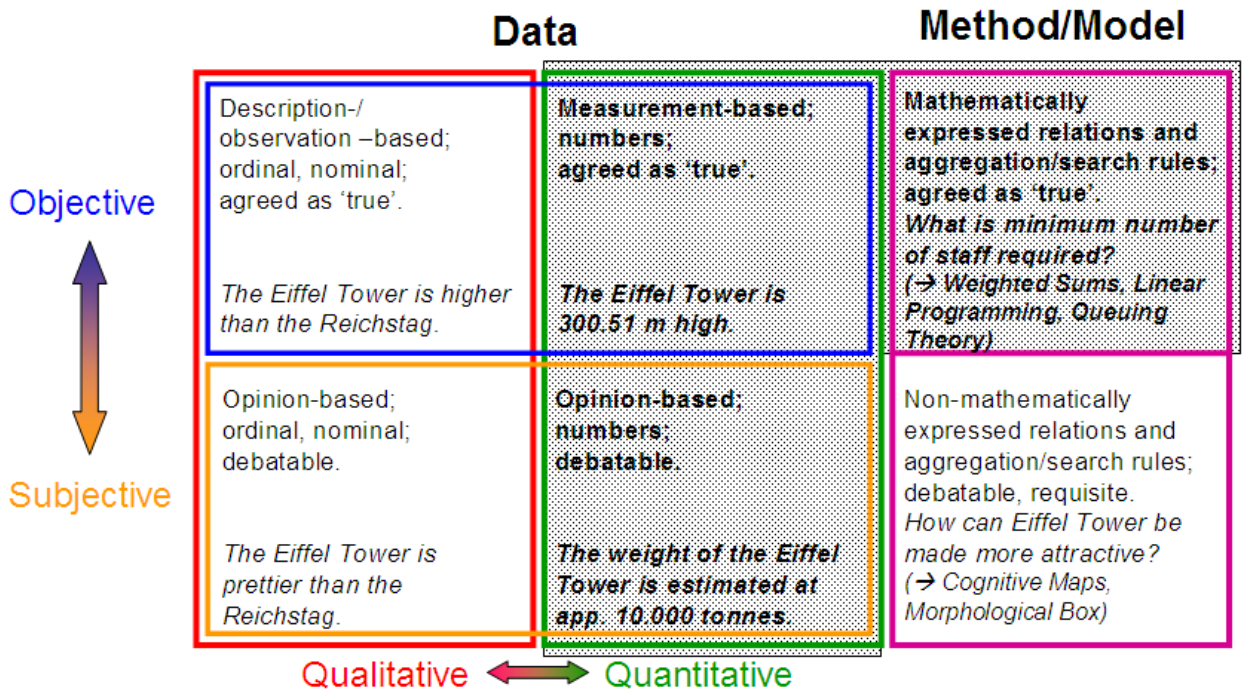


Figure 2-3a: Combinations of Data and Method/Model Types in 'Hard' OA (Shaded), with Examples.

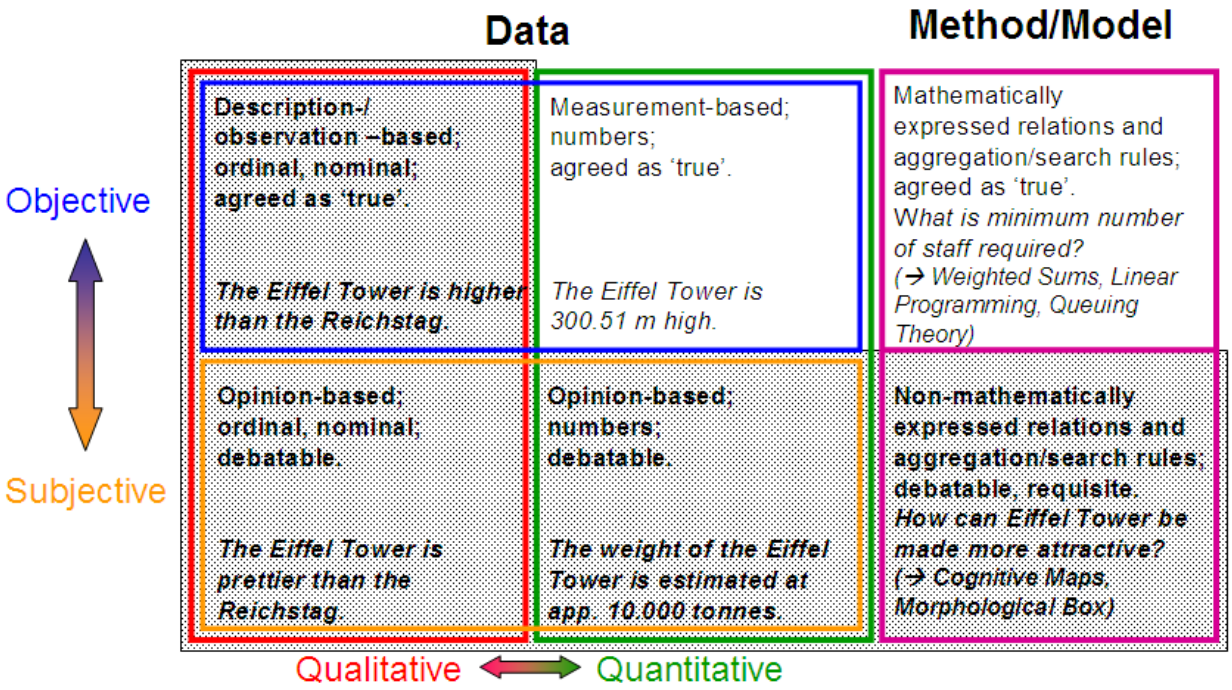


Figure 2-3b: Combinations of Data and Method/Model Types in 'Soft' OA (Shaded), with Examples.

Model-based decision support is the primary feature of OA and so it is of 'soft' OA. The type of models built and used (by using appropriate methods) in 'soft' OA, however, is different from that of traditional OA, as discussed in Section 2.4. The reason for this is that the nature of the problematic situation addressed by 'soft' OA is significantly different.

In general, building a model will enable (based on [3]):

- A convenient organisation (and most often visualisation) of the defining elements of the problematic situation and their interrelationships;
- A representation of a large amount of (qualitative and quantitative) information;
- Gaining a better understanding of the way in which factors influencing the problematic situation interact with the constitutive elements of that situation;
- Designing and investigating decision options and their consequences and determining which option(s) might be preferred over other options; and
- Enabling stakeholders to learn about the nature and root causes of a problematic situation by 'playing' with the model and thereby also gaining a better understanding of each other's viewpoints (i.e. the model is a learning tool).

A 'soft' OA model is, above all, a means to help people think about a problematic situation, understand and interpret its elements and factors of influence and their interrelationships, express and deal with views and opinions, identify crucial issues and come up with ways forward to address and cope with them.

By contrast, a 'hard' OA model is, above all, a means to search for an optimal solution to a well-defined problematic situation, or a 'satisficing' solution using mathematics-based heuristic algorithms.

2.6 BENEFITS AND OPPORTUNITIES OF DOING 'SOFT' OA

Now that the term 'soft' OA has been introduced and some key concepts and issues have been discussed, and before the guidelines for conducting a 'soft' OA study will be discussed in subsequent chapters, this chapter concludes by asking why one would use 'soft' OA in the first place.

There is a strong similarity between judgemental methods in operational research practice and a number of other modes of professional analytical practice. The closest relationship is perhaps with the domains of evaluation [12], social science (as described by SAS-074 [13]), business analysis, and elicitation (from experts) [14].

There are many issues when using traditional analysis techniques to analyse complex problems, as discussed earlier (e.g. in particular, understanding a system fully will assist in understanding the future behaviours of such a system). 'Soft' OA can incorporate multiple perspectives of the system and/or the problem and can help define boundaries and clarify assumptions and stakeholders' mental models.

'Soft' OA techniques can be used to try to make sense of these issues by bringing multiple stakeholders together to consider their multiple, often conflicting, views of the problem space. In particular, where there is a lack of clarity about the problem definition, disagreement and uncertainty about the issues and decision making, 'soft' OA techniques can play a large role in enabling stakeholders to make sense of the situation.

'Soft' OA techniques can help to manage the complexity within a problem space. They can consider both qualitative and quantitative data and information, including data that is incomplete or conflicting. Indeed 'soft' OA techniques are based on the judgement of stakeholders who are involved in the decision making.

For this reason, 'soft' OA techniques tend to be subjective in nature and hence multiple, and most likely conflicting, opinions of stakeholders could exist. But judgement can be treated as objectively as possible by following rules grounded in theory or established practice and by recording argumentation and rationale and agreeing on a sound process accepted by all involved.

In this remit, 'soft' OA can help to conceptualise and visualise the problem space and the issues, constraints and uncertainties within it. It starts to provide some structure to the problem to obtain a common understanding of the issues across stakeholders.

When using 'soft' OA techniques, there is often the need for a coherent and collaborative problem solving process because of the varied and conflicting stakeholder objectives and worldviews. A 'soft' OA analyst also needs to play the role of facilitator in order to achieve this successfully. Hence there is often the need for workshops and interviews in order to formally gather information. It is for this reason that 'soft' methods typically use subjective knowledge based on the judgement of stakeholders who are familiar with the problem space.

Stakeholders may have different priorities and different ways of working. 'Soft' OA can start to explore the disagreements and uncertainties that exist so that an agreed consensus can be developed and action can be taken. 'Soft' methods also enable individuals to consider other's points of view, and to consider how other people interpret the same experiences. When using these methods one can start to map out the relationships between individuals involved.

'Soft' OA can help one to start to make sense of the key issues and, although it often does not produce a perfect solution (there is no optimal solution to a messy problem), it can be a rather good approach to obtain a common understanding of the problem and the decision space, and to gain consensus amongst stakeholders on the way ahead.

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2.8 RECOMMENDED ADDITIONAL READING

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