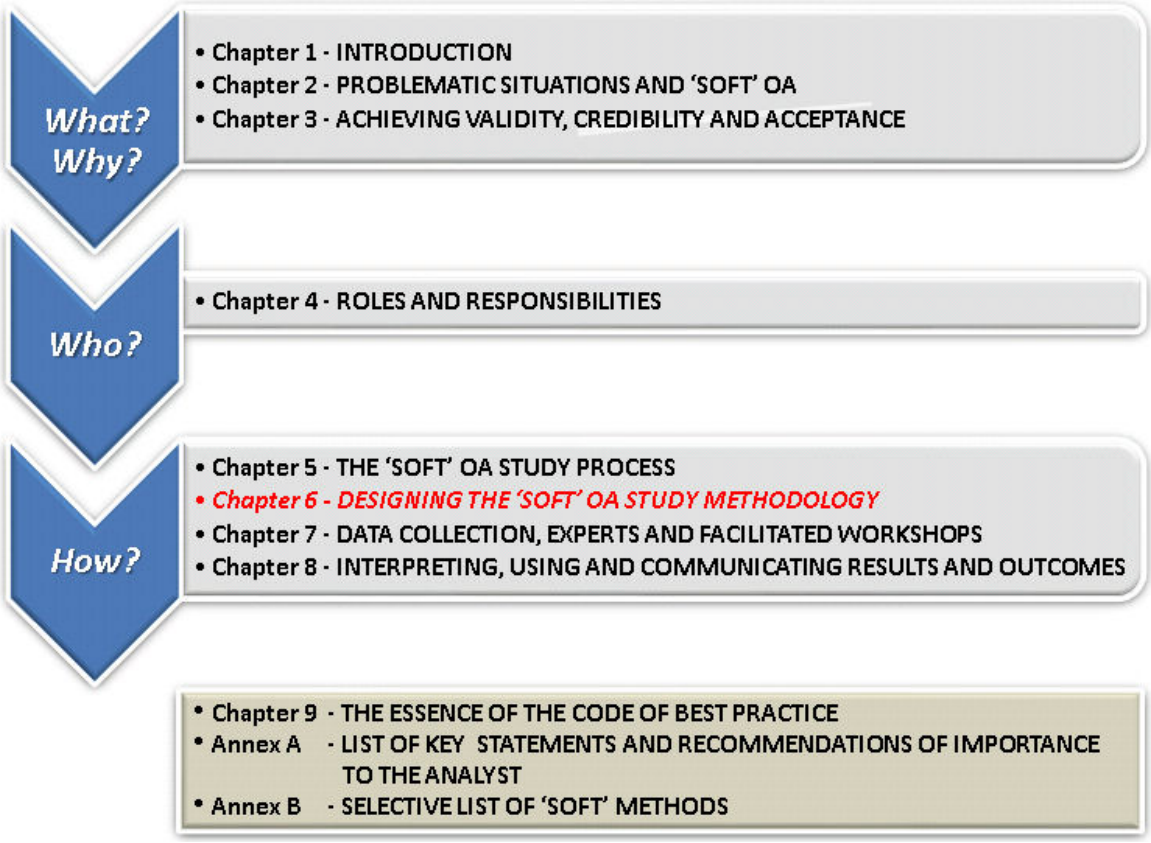
Chapter 6 – DESIGNING THE 'SOFT' OA STUDY METHODOLOGY



- Communicate with client(s) including key stakeholders and seek agreement on any assumption, action and delivery.
- Determine the most likely nature of the problematic situation by trying to shed light on key aspects.
- Decide on the appropriateness of a trajectory from perceived mess to either a problem proper or a manageable mess.
- Identify which type(s) of uncertainty exist(s) and contemplate on both the adequate attitude to uncertainty and ways of coping with it.
- Identify stakeholders and their interests and attitudes towards the study by conducting a stakeholder analysis.
- Decide on the appropriateness of a single or a multi-methodology study approach.
- Examine all methods on their merits to the problematic situation at hand and decide on the appropriateness of specific candidate methods. Recognise own limitations in knowledge/expertise and seek assistance.
- Decide on data and other resources needed including the use of software.
- Be aware of the danger of dissipation of results from 'hard' OA methods when interleaving 'hard' and 'soft' OA methods in a multi-methodology approach.
- Maximise objectivity and rigour, gauging the validity of the overall approach in terms appropriate to the problem domain being addressed.
- Document the argumentation and rationale for modelling decisions and keep a record.
- Document the argumentation and rationale for changes in the study's assumptions and aim (including aims of specific study phases), the definition (or, alternatively, the common understanding) of the problematic situation in order to ensure end-to-end integrity.

6.1 INTRODUCTION

This chapter addresses the design of the methodological approach of a study and in particular, whether and how different methods may be combined. As already stated in Chapter 1, the CoBP will not discuss specific methods but this chapter will provide general guidance to deciding on the choice of an appropriate study methodology and will give some examples of appropriate methods.

This chapter starts with guidelines as to how to determine the nature of the problematic situation since this will affect the methods and methodologies to be used. After that the chapter addresses the phenomenon of uncertainty in more depth than Chapter 2 by suggesting a typology which may be useful when designing the study methodology. The chapter then discusses stakeholder analysis and mapping as a follow-up on Chapter 4's discussion of the analyst's perspective on the stakeholders. The chapter goes on to address the modelling process and differentiates between a study approach based on a single methodology (usually for a small-scale study) and one that is based on multiple methods (usually for larger-scale studies). Collective experience (see e.g. [1]) has shown that most of the time, there is a need for a multi-methodology approach when addressing a mess. Much of what will be suggested regarding single-methodology studies – for example about choosing and designing a study methodology, about modelling issues, data requirements, use of experts, etc. – has a general validity and will therefore be valid for multi-methodology studies as well.

6.2 HOW TO COPE WITH PROBLEMATIC SITUATIONS AND RECOGNISE MESSES

When an analyst is called in for support, one of the first matters he has to consider is the nature of the problematic situation and the type of analysis that will be most appropriate.

Chapter 2 discusses three fundamental problem types that represent a broad spectrum of problematic situations: puzzles, problems (proper) and messes. At the outset of a study it may not be clear which type it is. Communication with the client(s) whilst referring to the main characteristics of the three problem types and to those listed in Table 2-2 should make matters clearer.

Below follows a step-wise approach which may help the analyst determine which type of problematic situation he is facing, before designing the study methodology: ask questions, follow a checklist, interpret the exploratory findings so far, decide on an additional trajectory to get things clearer in the case of a tentatively perceived mess.

The analyst must be able to discuss the client's initial statements (which could be ill-perceived) and identify which type should be assumed to be initially applicable. This could be done at an early stage of his involvement by asking questions regarding at least the following issues:

- Symptoms, possible causes, history (and: "is this all there is?": initially hidden problem behind stated problem);

> Anonymous client quotation:
> "I want to exclude unforeseen outcomes"

- Identification of stakeholders, and their backgrounds, interests, aims, and anticipated commitment; ("who is unhappy with the problem and why?", "who does and who does not want the problem to be resolved and why?", "who will and who will not be cooperating?", "when can the problematic situation be considered as 'improved'?");
- Uncertainties about the previous issues and resources needed and anticipated consequences of (not) addressing the problem, fear of these consequences, restrictions (and: "imposed by whom?");
- The relationship between the ultimate decision maker and the problem owner (and: "is there something to decide upon?", "is 'do nothing' a feasible option?", "why is this your problem?");

- Any deadlines, the time frame within which first deliverables are expected (and: "how urgent is this?"); and
- Payment and other administrative matters which however will serve as a means for the analyst to gain more insight into internal client relations ("who is paying?", "same person as problem owner?", "who is really willing to spend money"?).

When analysing the answers to the questions above, the following *checklist* (based on Chapter 2's Table 2-2 comparing 'soft' and 'hard' OA and its cited references, and also [2], [3]) will help the analyst determine if he is dealing with a messy situation, a problem (proper) or merely a puzzle:

- ☐ Not much is initially known about the nature of the problematic situation and its boundaries (what matters and what does not).
- ☐ Not much is initially known about defining the elements of the problematic situation and how they may be interrelated.
- ☐ Not much is initially known about who the stakeholders are and in what manner they may be directly or indirectly affected, their viewpoints and what they are worried about.
- ☐ Not much is initially known about the goals, objectives and measures of effectiveness or merit that may be relevant.
- ☐ Not much is initially known about what can and should be changed towards improvement of the problematic situation, and under what conditions or according to what criteria a change will be regarded as an improvement.
- ☐ Not much is initially known about the data needed, its relevance, availability and reliability.
- ☐ Not much is initially known about the way in which changes in context will affect the problematic situation, its improvement and the study design to achieve it.
- ☐ Power, emotion, politics and ethics will most likely come into play, but not much is initially known about how and to what effect.
- ☐ Different people say different things (or express different views) about the same issue.
- ☐ Not much is known about key interactions of human cognition, beliefs and behaviour.
- ☐ Not much is known about the context of grand-scale issues that have no clear end-points, transcend specific domains, and have significant political or public policy implications (e.g. counter-terrorism).
- ☐ Not much is known about where any possible resolution will most likely have side-effects attached to them that are undesirable by stakeholders.

The 'not much is (initially) known' part of the list above denotes that a large amount of uncertainty may exist: uncertainty about different aspects of a problematic situation and different types and levels of uncertainty. This will be discussed in Section 6.3.

The problematic situation may be regarded as a *puzzle* by the analyst if (virtually) none of the previous checklist items are ticked and if a search is required for a quantitatively underpinned outcome, preferably the best possible (the optimum), to inform the decision to be made. Some of the items listed in the checklist may require 'soft' methods to further delineate and define them. For example, there may be a need to interview stakeholders to agree the formulation of the model and the nature of the required solution, but this will be followed by a 'hard' modelling exercise in case of a puzzle.

The problematic situation may be regarded as a *problem (proper)* by the analyst if only a few of the previous items are ticked and there is a feeling amongst both the analyst and the client feel that agreement can be achieved in the formulation of the problem, the definition and (semi-)quantitative evaluation of the

potential solution options, and the procedure to achieve results. The study methodology will in this case most likely consist of a combination of 'hard' and 'soft' methods.

If most of the previous items are ticked the analyst will be wise to regard the problematic situation as a *mess*. In that case the CoBP suggests two ways forward: create a problem (proper) (i.e. a 'type 1 trajectory'), or, if that fails, continue to work in the mess space (i.e. a 'type 2 trajectory'). The two trajectories are discussed next.

A new combat boot had been introduced in Sweden when the number of foot injuries started rising alarmingly. The issue identified during the workshops using Morphological Analysis was a lack of knowledge of the range of injuries that had been sustained. A survey was conducted in order to map the issue. The survey was not part of the original study design, but an outcome of the acute lack of information the working group experienced. The morphological model was used the help shape the questions in the survey. Even though the study was not finalised as originally planned, the application of Morphological Analysis was valuable by transforming the combat boot issue from a mess to a problem, and by exposing the lack of data.

A *type 1 trajectory (perceived mess → problem proper)* should aim for a common agreement among the primary client and key stakeholders, before actually conducting the analysis proper, on at least:

- The formulation of the problem (creating a well-defined construct) one can work with;
- Setting initial restrictions[1] in physical, organisational, social, time-related, etc., terms as they could affect the analysis approach;
- The nature of the options and the ability to (semi-)quantitatively evaluate and compare them;
- The type(s) of model to be constructed and used, and the desired nature of results and the outcome of the study as a whole;
- Participants in the study (particularly in respect of specific types of expertise) and the information each individual will bring in (or give access to); and
- The internal phasing procedure of the study needed to achieve results.

A *type 2 trajectory (perceived mess → manageable mess)* should aim for a common desire, an initial commitment among primary client and key stakeholders, that something can and should be done to understand and change the current problematic situation. Along the way a clearer picture should be obtained of some key elements of the anticipated study, and thus turn the perceived mess into a mess that one can start working on:

- An identification and better understanding of aspects of the problem and the factors that influence it;
- The problematic aspects to be addressed and improved;
- A view of any boundaries to be set initially;
- The nature of the anticipated outcome of the study;
- Participants in the study (particularly in respect of specific types of expertise) and the information each individual will bring in (or may give access to); and
- An initial design of the internal phasing procedure of the study needed to achieve results.

Trajectory 1 could be a study in itself, the end of which could lead to the start of a problem (proper) solving study. Trajectory 2 will most likely be undistinguishable from the actual study, although one or two moments of reflection and a go/no-go decision could be built in.

[1] The definition of restrictions (i.e. boundaries to the study) at some stage of the study is important: how far to go back in history, for example, may determine whether or not some of the root causes of a conflict will be addressed.

Figure 6-1 illustrates the trajectory methodology for coping with problematic situations discussed above. A large part of it could be carried out in a facilitated workshop setting (ref. Chapter 7 on workshop facilitation) with key actors. Part of this process may be iterative (although not shown in the diagram) until a common understanding and agreement on the way ahead is achieved[2].

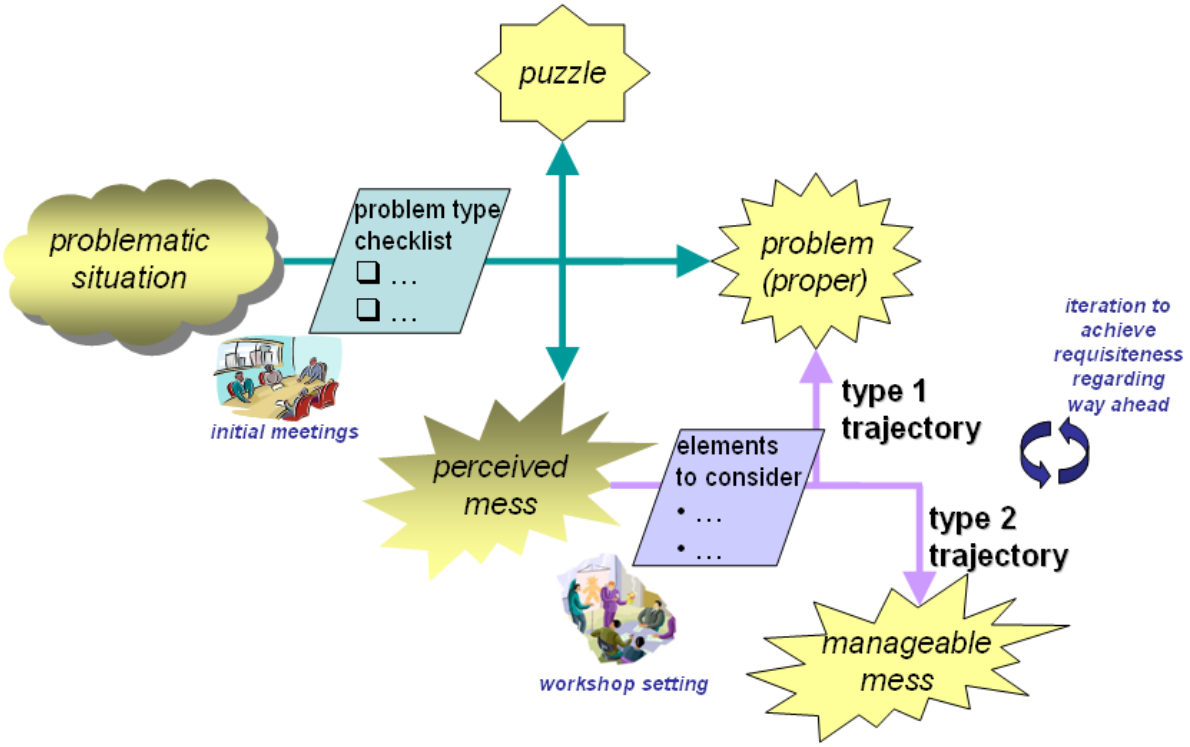


Figure 6-1: Procedure for Interpreting Problematic Situations and Identifying Their Nature.

Recall from Chapter 4 that the analyst very often has to 'prove' his competence in the methods and methodologies of 'soft' OA when a client's initial attitude is that of regarding the analyst as a technical scientist familiar with traditionally 'hard' analytical work. Adopting one of the two trajectories may be a way to show his skills at an early stage.

6.3 ANALYSING AND COPING WITH UNCERTAINTY

Uncertainty is a phenomenon that has to be coped with in any operational analysis as it is often the prime characteristic of the problematic situation. Chapter 2 discusses the concept of uncertainty in a general sense and suggests three different attitudes that one might adopt towards uncertainty. Each of them leads to some specific form of preparation for uncertain events. It is suggested in Chapter 2 that for coping with uncertainty related to the type of (messy) problems the CoBP is addressing, a mix of those attitudes will be most recommendable.

Before discussing the modelling process itself this section will discuss the various types of uncertainty in more depth with a view to the modelling consequences. This typology helps the analyst with identifying the nature of uncertainty that exists in the problematic situation he is dealing with and therefore with

[2] The concept of 'requisiteness' is usually applied to the modelling process (ref. Section 5.4), but it is also relevant to identifying a way ahead that is sufficient in form and content to resolve the issues at hand in the opinion of the group of people who will be involved in the study process.

determining which study methodology will be appropriate. At the end of this section some advice will be given regarding methods that are appropriate for certain types of uncertainty.

Much of what follows is based on Walker et al. [4] and Dreborg [5], which in turn are based on a large body of literature on uncertainty. That material has been adapted and extended for the purpose of the CoBP.

The list below constitutes a typology of uncertainty. A distinction can be made between the following dimensions and aspects.

- The *locations* of uncertainty; uncertainty may manifest itself in a number of elements of the modelling process:
  - *Model context*, which refers to the framing of the problem, the definition of problem boundaries, the identification of clients and other stakeholders and their perspectives, the identification of external sources of influence (e.g. adversaries, other threatening or non-threatening circumstances);
  - *Model structure*, which refers to the form of the model, the way in which concepts and relationships between concepts are defined, system behaviour;
  - *Model input and model parameters*, which refers to variables, data, values of parameters, description (expected behaviour) of external influence factors and the current system; and
  - *Model results*, which refers to estimates of outcomes/consequences, prediction error.

The other dimensions that follow are, in fact, characterisations pertinent to each of the uncertainty locations listed above:

- The *levels* of uncertainty; different degrees of uncertainty exist regarding the location of uncertainty, ranging from full knowledge (most likely quantitatively available) via partial (most likely only to some extent quantitatively and to some extent qualitatively available) to complete absence of knowledge:
  - *Stochastic uncertainty*, which derives from measurement issues such as imprecision and sampling error, and the inherent probabilistic nature of variables ('games against mother nature') – this type of uncertainty can usually be treated *quantitatively* as the event space will most likely be known.
  - *Scenario uncertainty*, which is uncertainty about the future external environment, the range of possible outcomes as a result of uncertain mechanisms although the probability values are unknown – two types of scenario uncertainty can be distinguished, both of which could be treated *quantitatively or qualitatively or as a mixture of both*:
    - *Intentional* (defence issues are normally characterised by the existence of adversarial actors, but this also includes situations where a number of stakeholders with divergent interests exist having the means to exercise influence); and
    - *Unintentional* (trends and developments to some extent autonomously leading to a future situation).
  - *Ignorance*, which ranges from 'known unknowns' when one still knows what one does not know, to 'unknown unknowns' when one even does not know what one does not know ('black swans') [6] – this type of uncertainty is usually *qualitative* and addressing it relies heavily on human judgement and imagination.

- The *nature* of uncertainty, which means that different sources (or perhaps rather: root causes) of uncertainty exist regarding the possible locations of uncertainty:

- *Imperfection of knowledge*, which may be reduced by more effort to gain missing knowledge (e.g. about adversaries, circumstances, stakeholders) or by involving subject-matter experts (who give informed estimates or their knowledgeable opinions) or perhaps merely by the passing of time as more information presents itself; and
- *Inherent variability*, which concerns social, economic and technological developments or natural events and may be caused by the inherent randomness (stochasticity) or dynamics of processes, technological surprises, and human behaviour and difference of opinion.

- The *time* dimension of uncertainty which means that the level or nature of uncertainty may or may not change over time:
  - *Dynamic uncertainty*, which is any uncertainty one will know more about *with time*, such as the weather, or the intentions of a specific adversary; it is essentially dynamic in relation to the degree of preparedness that exists with respect to a certain development, i.e. whether or not one knows in time what meaningful countermeasures to take; and
  - *Static uncertainty*, which essentially remains constant such as the probability of an accident occurring (assuming that no additional preventive precautions are taken as a preparation).

The analyst will need to distinguish between the dimensions and their underlying aspects in order to adequately design methods to cope with specific types of uncertainty. Figure 6-2 shows an uncertainty matrix (adapted and extended from Walker et al. [4]) with 'location of uncertainty' at its centre (vertical Y-axis), 'levels' and 'nature' at its right and left respectively (horizontal X-axis), and 'time' as the table's third dimension (Z-axis). The items on the X-axis characterise the items on the Y-axis. The items on the Z-axis characterise those on the X-axis for each of the location instances on the Y-axis. The result is a 3-dimensional matrix, where each cell may be elaborated further if that specific combination of location instance, level type, nature type and time aspect exists in the problematic situation the analyst is facing.

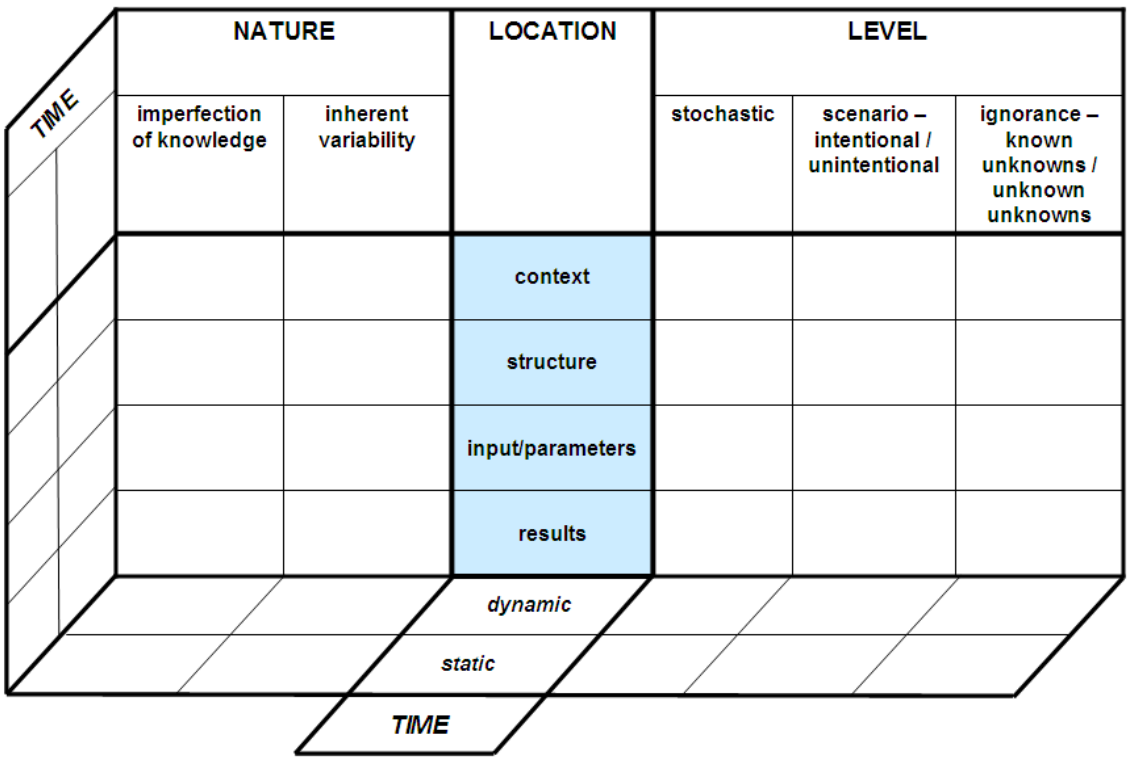


Figure 6-2: Table of Uncertainty Typology (3-dimensional) (Extension of a Table in [4]).

It must be noted that there are some relationships between 'Nature' and 'Level'; for example, imperfection of knowledge leads to ignorance. In addition, one could argue that 'static uncertainty' is an extreme case of 'dynamic uncertainty' as far as time is concerned. So, the dimensions are related to some extent.

The purpose of this table is to help the analyst find ways of dealing with uncertainty by:

- *Identifying* appropriate types of uncertainty in the preparatory pre-analysis phase of a study;
- *Choosing* appropriate methods in the Analysis phase (by examining their characteristics and relating these to the entries of the table in Figure 6-2) that are able to address identified types of uncertainty; and
- *Ex-post showing* that all relevant types of uncertainty have been dealt with by using the matrix as a quality control checklist.

In situations of uncertainty where a *quantitative* treatment would be appropriate, the following examples of methods would be useful:

- Risk management works well in a situation that is characterised by *stochastic* uncertainty, and can be used for *intentional* uncertainty as well. Risk management combines elements of all three attitudes towards uncertainty discussed in Chapter 2. Risk management needs to be supported by other approaches in situations of strong *qualitative* uncertainty.
- Game theory has been used successfully in situations where *intentional* uncertainty is strong, but it does require that the rules of the game be known quantitatively. Thus game theory is less suited were *intentional* uncertainty is combined with *qualitative* uncertainty.
- Decision trees are suitable for exploring situations of *dynamic* uncertainty, but again assume mainly *quantitative* uncertainty to work well.

If the situation is characterised by large elements of *qualitative* uncertainty, other, predominantly 'soft' approaches are called for. One important approach is scenario planning ([7], [8], [9]), which helps by imagining possible futures were different rules apply. In essence, scenario planning is used to explore bits of the event-space. Other methods can be used to similar effect, often in combination with scenario planning (e.g. Morphological Analysis [10]).

Early 2003, the Swedish Army leadership felt that the Army units no longer had a unified sense of purpose. As the focus of the Army had gradually shifted from homeland defence towards conducting missions abroad, the unity of purpose was gradually lost.

In order to address this challenge, a scenario planning approach was chosen. Workshops were assembled where a representative selection of Army personnel was present. They were tasked with brainstorming driving forces that could be regarded as important and uncertain. The key question was "Does Sweden need an Army in the future?". Based on the identified driving forces four scenarios were constructed, describing four 'worlds' in 2025 and addressing security issues. The scenarios were called "Democracy for all", "Renaissance for realpolitik", "Usama's triumph" and "Baltic focus".

The scenarios were used to show that some ground fighting capability would be required in all scenarios, but also that the conditions and requirements regarding that force would be very different in the four futures.

In situations where *intentional* and *qualitative* uncertainty is prevalent, various table top (war)gaming approaches have been successful (e.g. [11], [12]). By assuming the roles of potentially adversarial or co-operating actors one uses one's empathy and imagination to think of some of the novel moves the real actors might apply. A specific form of *qualitative* and *intentional* uncertainty is involved with identifying the possible consequences of actions one may take in order to address the problematic situation. In order to approach this issue gaming may be relevant as well.

When dealing with *dynamic* and *qualitative* uncertainty, one useful option is to use adaptive planning approaches, i.e. devise options that retain as much freedom of action as possible in the face of an uncertain future. The Strategic Choice Approach and Robustness Analysis (both in [13]) are helpful in these situations. System Dynamics, possibly in combination with Group Model Building [14], would be another

useful option for this type of uncertainty, but also for a situation where *dynamic* and *stochastic* uncertainty exists.

A rather different approach to addressing uncertainty is Assumption-Based Planning [15]. It is not limited to any particular type of uncertainty, but is used to revise and strengthen an already accepted plan. In essence, it is designed to identify critical assumptions in order to suggest shaping and hedging actions that will improve an existing plan.

The fundamental point about uncertainty is that it has to be managed properly in the study process, and while it cannot be eliminated its implications can be understood. Importantly, the analyst should not treat it as a commodity to hand on to the decision maker.

6.4 STAKEHOLDER ANALYSIS

At a (very) early stage of the study, the analyst, in partnership with the primary client and possibly other select members of the client system (ref. Chapter 4), normally conducts a stakeholder analysis exercise ([16], [17]). The objective is to:

- Develop a list of stakeholders;
- Identify the stakeholders' key characteristics;
- Identify potential risks to the study (e.g. uncooperative stakeholders and their possible adverse effects on the study); and
- Develop insight into how stakeholders should be engaged and managed during the study (e.g. how much attention to devote to each stakeholder, which stakeholders to invite to workshops, which stakeholders to include in formal communications regarding study outputs, how to manage pluralistic competing stakeholder demands).

The first of the following two sub-sections addresses what aspects of stakeholders should be analysed and what the challenges to this analysis are. The second sub-section will briefly discuss some examples of how an analysis can be conducted in the form of stakeholder mapping.

6.4.1 The Challenges of Analysing Stakeholders

A stakeholder analysis is conducted as part of the (initial) problem framing process. It is repeated regularly during the study on a (preferably) proactive or on a reactive basis. Revisiting and revising is required since the stakeholder community is not static (e.g. as the study progresses through its lifecycle the members within the community may change and/or the perceptions of individuals may change). The stakeholder analysis may need to be kept private as the primary client may be uncomfortable with an explicit record (see also Chapter 3).

For each stakeholder who is identified, assessments may be made of the following:

- The stake in the study;
- The awareness of the study;
- The interest in the study (e.g. why is he interested, what are his expectations and objectives, is he directly or indirectly affected);
- The perception regarding the study (e.g. does he believe that he will gain an advantage or be disadvantaged through the study);

- The position (e.g. internal or external actor, organisational membership, title or rank, place in the organisational hierarchy);
- The power and influence (e.g. ability to support or to sabotage the study process and resulting actions, ability to influence based on his network of relationships, his importance within his organisation, his resources);
- The relationships with other stakeholders (e.g. potential for conflict, potential to act as an opinion leader, which stakeholders have similar interests and views, possibilities for forming coalitions);
- The attitude towards the study (e.g. supportive, neutral, obstructive);
- The legitimacy in relation to the organisation;
- The urgency of the claim on the organisation (e.g. how important is the study to the stakeholder and how prepared is he to act (supportively or obstructively) to achieve his own desired outcomes); and
- The knowledge, experience and expertise in areas of interest to the study (e.g. how could he contribute to the study, participation possibilities).

A stakeholder analysis is by nature subjective and incomplete:

- There are uncertainties and inconsistencies in participant assessments;
- There is always a residual uncertainty about the will and purpose of the stakeholders (even involved stakeholders may choose not to disclose all their intentions);
- The information on external stakeholders in particular will be difficult to determine and will be incomplete (e.g. biased assumptions, use of stereotypes); and
- The stakeholder community is dynamic (e.g. members influence one another and change their stances, coalitions form and break up, new members enter and old ones leave, power shifts, interests change).

> A seminar war game (SWG) on the Canadian Army of Tomorrow examined military operations of the future by incorporating both military and civilian (e.g. police, diplomats, aid agencies, scientists, and others) judgements and perspectives. It provided a means to 'meld' these diverse judgements together in order to produce insights into future operational challenges and opportunities. 'Soft' OA helps engaging stakeholders who come from different cultures and have very different points of view.

Addressing stakeholders within the study team is a matter of conducting effective facilitation that is trusted by the stakeholders. If the group of stakeholders that needs to be involved in a certain study phase is too large for conducting a single workshop, then a series of workshops may be conducted or other approaches may be found to engage all key actors (e.g. workshops supplemented by interviews). The benefit of involving stakeholders is that they may voice their concerns and find common ground in a problem definition, and ultimately be supportive of actions suggested by the study. Involving a larger number of stakeholders may also increase the quality of the problem definition, as each stakeholder brings in a new perspective on the issue. The drawback may be that stakeholders with sufficiently divergent interests may block any development of a common view and may get information that may benefit a contradictory purpose. Some may even attempt to bend the study to suit their own ends.

6.4.2 Stakeholder Mapping

Decisions have to be made on how to address the stakeholders within the study context. Using the analysis discussed in Section 6.4.1, a stakeholder mapping can be designed to help categorise stakeholders and identify ways of coping with them. Stakeholders with high power and high interest, for example, are likely to be critical to the implementation of the study's recommendations. Some of those stakeholders may perceive themselves to be winners, and others may perceive themselves to be losers, within the study context.

The stakeholder mapping provides a visual representation of some of the key parameters useful in characterising the stakeholders. Depending on the technique used, the mapping may be in tabular, graphical or pictorial format (see for example [16], [17] for a more in-depth analysis).

For example, a grid may be drawn with power (or influence; i.e. the capability to affect the study and achieve outcomes) along one axis and interest (in the study and its outcomes) along the other. The scale for power may, for example, be chosen to correspond to a high-low categorisation. The scale for interest may, for example, be chosen to be characterised as high-low or as similar-divergent. Stakeholders can then be placed within the quadrants based on their power and interest.

Other examples would include: opposing power to dynamism (predictability of a stakeholder's stance), or power to legitimacy (of the actions of the stakeholder in terms of desirability or appropriateness) and to urgency (the study's criticality and time-sensitivity as perceived by the stakeholder).

The clustering of the stakeholders provides an indication of possible stakeholder groupings in terms of their degree of importance to the study's success, and possible management strategies for each grouping. Examples of management strategies for each of the quadrants or combinations include, but are not limited to:

- Keep the stakeholder informed;
- Have stakeholders actively participate;
- Try to influence stakeholder; and
- Monitor stakeholders.

The analyst conducting the stakeholder mapping needs to consider his own roles, objectives and relationships with the stakeholders. Successful stakeholder negotiation needs to give due consideration to both voice (i.e. participation) and procedural justice (i.e. agreement on the fairness of the rules followed during collaboration).

6.5 CHOOSING THE METHOD

As far as the study methodology is concerned, there is a decision to be made if the study will use an approach based on a single method or methodology or a combination. The next two sections will address each type of approach separately. This section and its sub-sections will address the modelling process in general terms and those problematic situations where the study approach in fact relies on one single methodology or method. This will most likely be the case with problems having a narrow scope, a limited aim, or with separate (partial) studies each addressing a particular stage or activity of a larger-scale study. Practical experience suggests that multi-methodology (to be treated in Section 6.6) will be the more usual choice when facing messy problematic situations and certain more 'messy' instances of problems proper.

6.5.1 Deciding on the 'Soft' OA Method

The following *criteria* are suggested for consideration when deciding on which methodology/method is appropriate for addressing the problematic situation at hand (partly based on [18], [19], [20]):

- *Fitness for purpose* of the task to be conducted and the type of results desired. This includes the following aspects: the nature of anticipated outcomes, conformity with the divergent or convergent stage of the study[3], mental demands made of clients, but, most important and in fact integrating the previous aspects, appropriateness for developing and/or using the model to represent the problematic situation or support dealing with it.

[3] Particularly where group work is involved, there may be a need for facilitating both divergent and convergent thinking. As both types of thinking usually require different supporting methods, the notion of mixing methods ('multi-methodology') becomes natural (ref. Section 6.6 and [20]).

In each phase of the study (ref. Chapter 5) decisions have to be made concerning the general method and specific techniques to use for the different tasks in that phase; each of them should be fit for their purpose.

- *The nature and degree of uncertainty* involved and to what extent it should be coped with by the method. This criterion extends the previous one if uncertainty is a fundamental characteristic of the problematic situation the methodology/method is designed for.
- The degree to which a candidate method is accepted as *formally sound* or grounded in theory and/or proven to be successful in similar circumstances.

> One of the factors considered in the choice of an analytical approach to examine issues related to the Canadian Army of Tomorrow was the cost of the study. Conducting a seminar war-game (SWG) required less resources and less time than simulation-supported experiments and field trials with military personnel. However, the SWG was able to contribute valuable insights for filtering out less promising alternatives, for structuring future studies and for determining who from the diverse stakeholder systems should have a role in those studies.
> The SWG, as an example of 'soft' OA, is sometimes (but not always) a less resource intensive alternative.

- *Pragmatic reasons* based on, among others, time, budget and availability of people to be involved.
- *Data requirements* and other model-related resources such as availability of software and other supporting material.
- The *analyst's knowledge* of, *competence* in and *experience* with applying the (mechanics of the) method.
- The *facilitator's knowledge* of, *competence* in and experience with ways ('methods') in which groups should be guided and stimulated to achieve results, including coping with issues of dysfunction and disagreement, if the method requires group sessions. If not, are additional facilitators available and able to fit in the team?
- The degree to which the *clients* and other *stakeholders understand and feel comfortable* with the proposed method.
- The degree to which the *organisational culture* agrees with the proposed method.

Below follows an example showing how the nature of a problematic situation influences the nature of the methodology to be chosen.

Table 6-1: Relationship Between Problem Nature and Methodology (Adapted from [21]).

Nature of Problematic Situation	Nature of Methodology
Very complex and important to stakeholders.	Should increase quality of communication.
Very political where stakeholders have hidden agendas.	Should visualise and relate issues, impartially facilitated.
Very data rich where stakeholders aim for concrete options.	Should integrate opinions and data and create options and show consequences.

Creating a model which is a representation of the problematic part of (real or perceived) reality that people wish to deal with, requires a methodology or a method in itself. This (procedural) methodology or method is a structured set of guidelines or rules and will be applied by the analyst or by a group of people (in a 'facilitated modelling' mode). The application of different (procedural) methodologies/methods for setting up a model will most likely produce different models for analysis. None of them may be correct, but some of them will be more useful than others.

Some of the methods in the field of judgement-based OA are strongly associated with individual academic researchers and practitioners, often those who first characterised the method, exploited it and published their experiences of using it. Some methods are asserted to be exclusively useful for specific types of problematic situations, e.g. the exploration of strategic issues for organisations. Practitioners wishing to apply a specific method are advised to take an open approach and examine all methods on their merits in the problematic situation on hand before deciding which method to use. This state of affairs perhaps reflects the maturity of 'soft' OA. In a more established science, such as physics, there are standard approaches to tackling issues. This convergence has not yet emerged in 'soft' OA and while there are standard methods such as influence diagrams, there is still individual preference in choice of methodology.

The reasons why a particular method is chosen should be documented and accounted for. The same holds when it has become apparent that it is necessary to deviate from the formalities of a particular method or to adopt a multi-methodology approach.

6.5.2 Deciding on the Model's Resources

There are two related issues that must be dealt with when developing a model and applying a method: the nature and the origin of data. On the one hand, these two determine the way in which data is collected and used as input to a model. On the other hand, they depend on the type of model which, in turn, depends on the study's, or study activity's, purpose for which the model will be constructed and the type of results that are desired.

Figure 6-3 shows how a series of requirements originate from the aim of the study, leading to data resource requirements. The nature and origin of the data, in combination with other intrinsic data quality factors, affect, in turn, the model and its results and thus the achievement of the study aim. Also with the model and its results there are additional, more intrinsic, quality factors that affect the series of achievements, as shown. In the end, there may be a mismatch between what the study aim required and what could be achieved.

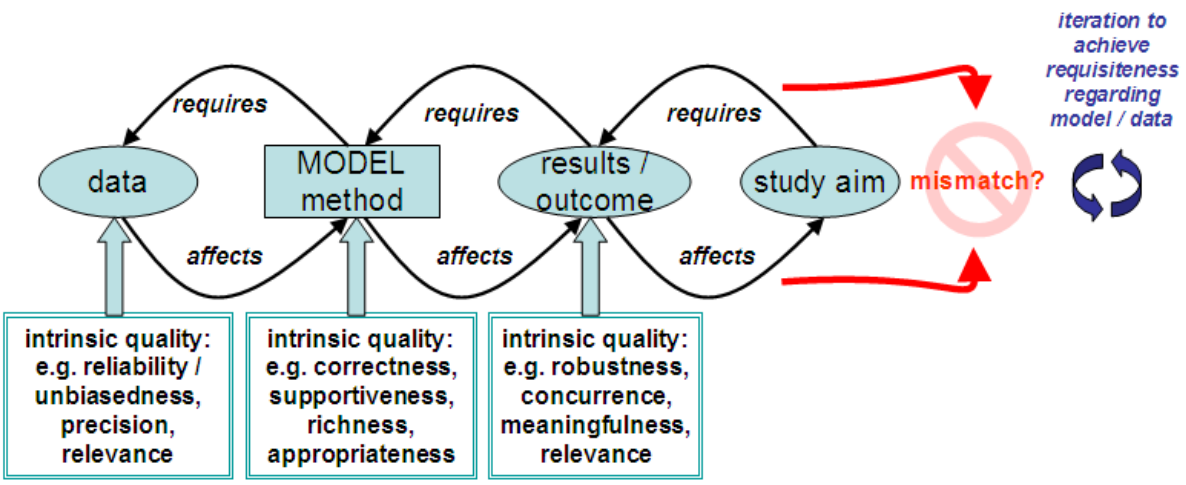


Figure 6-3: Data and a Possible Mismatch Between Requirements and Achievements, in Addition to Other Intrinsic Quality Factors Per Key Study Component (This may be an iterative process until requisiteness is achieved; ref. Section 5.4).

Figure 6-3 is valid for OA in general, but in 'soft' OA data largely depend on people and their judgements and much less on numbers and figures. This adds a particular dimension to the subject as these judgements represent people's beliefs and assumptions about the problematic situation, their preferences, and their estimates of otherwise unavailable numerical data. Chapter 2's Figure 2-3 makes a distinction between

quantitative and qualitative data, and between objective and subjective data. The nature of data can be manifold; commonly accepted theory however defines a limited number of formal scales on which data can be expressed and phenomena can be measured.

6.6 CHOOSING A COMBINATION OF METHODS – MULTI-METHODOLOGY

Experience has shown that a large number of problematic situations require combining different methodologies and/or methods.

While acknowledging the already multi-disciplinary nature of OA itself, any operational analyst should also be aware of possibly appropriate methods and methodologies from other fields of analysis: economics, psychology, sociology, political sciences, ethics, etc. This requires an open mind and out-of-the-box thinking by the operational analyst and an preparedness to call in or at least consult colleagues from those other fields.

Typically, as knowledge in a problem space is elicited and captured, the preferred methods become more focussed and specific, often creating opportunities for quantification of the problem space, with attendant statistical analysis.

Particular care needs to be taken where 'soft' and 'hard' methods are interleaved. In general, the relative simplicity of representation achievable by a 'soft' method can significantly degrade the credibility and resolution of predecessor 'hard' techniques. A 'hard' method can successfully address the interaction of distinct factors; if a 'soft' method is subsequently applied to the outputs of that 'hard' method, there is a danger that the impact of such interactions will be dissipated by the architecture of the 'soft' method. A final opinion-based step may be defensible especially if it involves the decision makers themselves. Difficulties arise in particular where a judgement-based step is planned between the application of two 'hard' methods.

Noting the caveat above, even when relying on 'hard' OA methods, 'soft' approaches may be helpful for the initial problem shaping and structuring tasks of the Appreciation and Assessment phases; perhaps for its subsequent Analysis and Action phases as well, in which, for example, a range of measures of effectiveness need to be embraced and interpreted together. The overriding requirement is to strive to maximise objectivity and rigour, gauging the validity of the overall approach in terms appropriate to the problem domain being addressed.

In supporting the development of new operational concepts for maritime mine counter measures a multi-methodology approach was designed:

- Methods used in the 1st work package were: scenario development and analysis, capability analysis.
- Methods used in the 2nd parallel work package were: technology survey and assessment.
- Methods used in the 3rd subsequent work package were: morphological analysis (for concept design), multi-criteria analysis (for concept evaluation).
- Methods used in the 4th subsequent work package were: additional technological analysis, in-depth multi-criteria analysis.

The above is an example of a problematic situation requiring addressing multiple problem aspects and therefore applying a multitude of appropriate methods.

'Multi-methodology' is a rather ambiguous term as it can be understood as:

- A '*multi-method (or: 'mixed-method') methodology*': a combination of different methods from a single methodology (e.g. use of various aggregation methods all belonging to the methodology of value-based multiple criteria decision making); and
- A '*multi-method multi-methodology*': a combination of different methods from different methodologies (e.g. use of a mapping method belonging to the methodology of conceptual mapping and a value-based multiple criteria decision-making method). One of the methodologies may be dominant and will then be enhanced with suitable methods from one or more other methodologies.

The CoBP continues using the term 'multi-methodology' for both interpretations as has become customary in the 'soft' OA literature[4]. Some authors also account for the paradigm level (single versus multi-paradigm; ref. Section 2.4) when defining multi-methodology. The CoBP will not address that issue as it takes the stance that 'hard' and 'soft' OA are not really different paradigms.

6.6.1 Deciding on a Multi-Methodology Approach

There are three main reasons for *deciding to adopt* a multi-methodology approach ([22], [23]), which is a common and successful practice among experienced and knowledgeable practising analysts:

- The *problematic situation is multi-dimensional* (ref. Chapter 2): there are multiple problem aspects and/or distinguishable problem parts, multiple actors with multiple perspectives and multiple objectives, multiple types of information resources and sources of uncertainty, which may all require their own way of being coped with.
- The *study process is multi-phased*: each phase may have a different nature posing different tasks and activities and thus requiring its own dedicated methodology.
- The *usefulness of enhancement and triangulation*: different methods or even methodologies applied to the same issue may produce different results which can widen the scope of the study and open up the option space but can also be used for validation and for coping with weaknesses of particular methods. A particular example would be that requirements of one method uncover gaps in the analysis conducted with another method.

Sometimes, using different methods just happens as the study evolves and insights change.

It must further be noted that a multi-methodology approach can be designed as a serial or as a parallel process, or even a combination. A *serial multi-methodology* approach means that the combination of different methods and methodologies occurs across the different study phases or even across subsequent activities within a phase. Each subsequent phase or activity relies on a specific method or methodology. A *parallel multi-methodology* approach (although less common) means that different methods or methodologies are used in parallel within the same study phase (mainly for the purpose addressed by the third bullet above).

Taking the above-mentioned argument of usefulness further, a problematic situation which possesses more characteristics of a mess or even a problem proper than of a puzzle, will also be more appropriate for the use of different methods. Using different modelling methods will most likely produce different models thereby opening up different perspectives of the situation and stimulating discussion; this is an example of parallel multi-methodology. Section 5.4 also discusses serial and parallel approaches.

> A UK study of the value for money of the *Falcon* communications system demonstrates the power of complementarity. The system has the potential to generate several benefits, each assessed by a different combination of techniques: military organisation *flexibility*, through a network model informed by a multi-criteria analysis; enhanced powers of *manoeuvre*, by logical analysis of interoperabilities; operational *pace and advantage* by a network efficiency model based on judgement; '*operational picture' completeness* through a 'hard' network simulation of data flows; and battle outcome from a simulation which drew on these parameters.

The diagram in Chapter 3 (Figure 3-1) shows that a problem structuring analysis may identify specific issues that need exploiting by methods from 'hard' OA. This would be a perfect example of 'soft' and 'hard' OA complementing each other.

[4] In addition, it should be noted that multi-methodology need not involve mixing whole methods. Elements of different methods may be taken together to, in fact, create an integrated new method. An existing method could be enhanced (enriched) by elements of another method.

There are also reasons for perhaps *not adopting* a multi-methodology approach if it is felt that the challenges listed below cannot be coped with ([1], [22], [24]):

- Some schools of thought (at companies, advisory or academic institutions) advocate their own *preferred methodology* and will not be prepared to use another methodology. If they are part of the same study team, this may pose a cultural and organisational barrier to a multi-methodology approach. This has to be identified and negotiated at as early a stage as possible.
- Some theorists point at *theoretical difficulties* with combining certain methodologies, especially when they feel that methodologies belong to different paradigms. In practice this means that it may not be clear how results from one method could or should be used as input to a subsequent method. Some adjustment or interpretation may be necessary, which has to be recorded. In addition, that same practice shows that this theoretical issue is of minor importance with the exception of the issue of interleaving 'hard' and 'soft' methods (discussed earlier in this section).
- Along similar lines as the previous reason: moving from one methodology to another may pose *cognitive difficulties* to *analysts* as this movement may require not only an altogether different analytical attitude but also specific practical skills. There may exist cognitive difficulties for *clients* as well who have to adapt themselves to, for example, different representations of problem issues. The analyst therefore needs not only to explain what is expected of clients but also to seek assistance if his expertise/knowledge seems insufficient.

6.6.2 Designing a Multi-Methodology Approach

Recall from Chapter 5 the four main activity-oriented *phases* of a study: appreciation, analysis, assessment and action. They can also be used to design a multi-methodology approach assuming that each phase's nature and tasks call for its own dominant methodology (or method).

Add to this set of phases three 'worlds' in order to create a full matrix of different dimensions which might act as a framework to design and appreciate the elements of a multi-methodology approach. These 'worlds' (material, social, personal) are based on the work by Habermas [25], but will for the purpose of the CoBP be loosely interpreted as the following respective *domains*:

- The objective, observable domain ('what we see');
- The inter-subjective, participatory domain ('what goes on in groups we participate in'); and
- The subjective, individual domain ('what we think and experience ourselves').

Table 6-2 shows the matrix-like framework, very similar to the one Mingers suggested [19][5]. Each cell contains a few phrases characterising the specific combination of phase and domain and suggesting the nature of the methodology(ies) to consider. The actual choice does, of course, depend on the key ingredients of any study design (ref. Chapter 5): the problematic situation itself, the people involved, the nature of the decision to make, the nature of the data and information required to produce outcomes that can inform the decision.

[5] An alternative approach for choosing a combination of methodologies is 'Total Systems Intervention' developed by Flood and Jackson [27]. Mingers' approach fits more closely with the terminology and study phasing adopted in this CoBP.

Table 6-2: Framework for Designing a Multi-Methodology Approach Using the General Study Phasing of Figure 5-2 (Adapted from [19] and [22]).

Study Phases→ Domains ↓	Appreciation of:	Analysis of:	Assessment of:	Action to be Taken:
Objective/Observable	(Physical) circumstances; organisational demands.	Correlations and causal structures; external influences.	Alternative options and their impacts.	Select and implement.
Intersubjective/-Participatory	Power relations; group dynamics.	Conflicts; common interests.	Alternative (social) structures.	Generate consensus and mutual empowerment.
Subjective/Individual	Emotions; beliefs; meanings.	Perspectives; perceptions; rationality.	Alternative conceptualis-ations.	Generate agreement and commitment.

The following steps will usually have to be followed for making that choice [23]:

- *Review* the problematic situation and the state and progress of the study;
- *Determine* what is required to make a further step toward the next study phase (and thus toward the aim of the study);
- *Be aware* of the methods and methodologies that are available for what is required and understand which of them are useful and in what ways; and
- *Choose* the most appropriate methods taking into account not only criteria related to the issues mentioned in the previous steps and to identified uncertainty types, but also to study constraints (budget, time, agenda, etc.) and analytical or other requirements (skills and experience, cognitive demands, cultural barriers, etc.).

Attempting to position candidate methods in the cells of this framework will not only show which study aspects can be covered but also which cannot and thus remain open (the reader is referred to [26] for examples). A discussion should be organised between analyst and client about what to do with a 'white spot' and whether or not it might be acceptable or whether a new, possibly modified, method or methodology should be designed.

The most important matter of attention for an analyst proposing a multi-methodology approach should be to explain and discuss the proposed methodology and gain commitment with the primary client and preferably with other involved key individuals as well.

From practice [1] it must be concluded that the choice of methods evolves during a study based on reflections along the way and can therefore not be fixed at the study's beginning. In addition, the choice of the methods and methodologies to be combined largely depends on the knowledge, experience and competence of the analyst as noted earlier. Any analyst must consciously reflect on his methodological decisions and be prepared to consult with colleagues; he should even ask them to join the team if and when the success of a study (and the satisfaction of the client) does so require.

6.6.3 Applying a Multi-Methodology Approach

Applying a multi-methodology approach needs continuous reflection on at least the following four issues (inspired by [20], [28], [29]):

- The *division of roles* between the analyst(s) and the facilitator(s), and among analysts and among facilitators if there are more than one.

  Refer to Chapter 4 for remarks on the differences between an analyst and a facilitator. Each has his own role to play, in principle, but the roles can be played by one single individual. Although there can be one principal analyst or facilitator who is most familiar with a particular method used within the study, it is wise to have basic knowledge of that method present with all analysts/facilitators. Knowledge overlap will contribute to informed assessment of the suitability of the elements of a multi-methodology approach, the successful integration of the results, and help ensure that informed support (e.g. technical support, use of software) can be provided by the non-principal analyst/ facilitator.

- The *translation of results* from one method to another.

  The results of one method may not be in the correct format for or may be otherwise unsuitable as input to another method. For example, a causal map structure containing cycles of influence cannot be used as such as a formal value-based multi-criteria model which usually cannot cope with cycles. So, there has to be a translation of one to the other. This is a non-obvious task to be carried out by skilful analysts, but surprisingly little reported on in the literature.

- The *combination of results* from different methods to the overall study outcome.

  Although the initial design may be a serial approach (each subsequent study phase requiring its own single method contributing to the overall study aim), it can happen that for reasons of enrichment or triangulation or challenging or opening up the options space (ref. Section 6.5.1), a parallel approach is adopted. The different methods applied in a single study phase, all contributing to the anticipated outcome of that phase may pose a challenge as to the nature of the combined results.

  At the results level of the individual methods there can be mutual confirmation, i.e. results all point to the same direction, but also contradiction (see also Figure 6-3). In the latter case, there has to be some degree of reconciliation at the outcome level (outcome based on the results) in order to allow study progress. This can be achieved by a discussion of the pros and cons, meanings and consequences, and reliability and other caveats of the various findings.

- The *validity of the end-to-end integrity* of the study.

  Moving from study phase to study phase and subsequently applying methods may lead to new insights along the way, but also to the danger of loosing sight of the over-arching study philosophy and its initial assumptions (e.g. about the features of the problematic situation). Adjustment of these defining elements according to the new insights, for example by updating an initial cognitive map, will help prevent losing the study's end-to-end integrity and provide a record of the study's progress.

6.7 COMPUTER SUPPORT

'Soft' OA can be conducted using high, medium or low technology approaches. When computers are used, they may be used interactively during sessions with the participant(s) (e.g. interactively building and refining models visualising and structuring the problematic situation) or after such sessions in an analysis mode. A specialised use of computers in facilitated workshops (ref. Chapter 7 on workshop facilitation) has arisen through the use of keyboard-entered, rather than oral, contributions. Anonymous contributions may be made, allowing speculative thinking and avoiding domination by senior military officers.

Computers, because they are useful for storing, retrieving, manipulating and communicating information, can be a powerful tool that helps the facilitator and the group to accomplish their tasks [30]. Computers may also be used in modes that provide anonymity to participants and so help manage personality issues

and pressures resulting from military rank differentials among participants. However, their use should not be allowed to intrude too much on group interaction. Participants concentrating too much on computer screens rather than on each other may neglect building the group relationships and dynamics that are critical for the development of robust solutions.

At all stages of a study there may be an opportunity for or even a need for computerised support of the modelling process[6]. This however requires considering very thoroughly the aspects discussed in Sections 6.5.1, 6.6.1 and 6.6.3 (see also [32]), as computerised models can not only be helpful and enhance process efficiency and effectiveness but can also be constraining to some degree. It should not be taken for granted that some model software perfectly matches the requirements of a problematic situation. In addition, in a multi-methodology approach, usually some effort is required to transfer output from one computer model to input for another. Moreover, some technical knowledge may be required to operate the software; a technical facilitator will usually be needed for support. Nevertheless, problem structuring, visualising models, executing calculations for those parts of the analysis that require some 'hard' OA techniques, comparing options, investigating their (possibly time-dynamic) consequences and synthesising information, visualising results, all may and indeed have proven to benefit from computer support (e.g. see [10] for computer-supported problem structuring and scenario creation using Morphological Analysis). The level of computer support may vary considerably though; some 'soft' approaches rely almost exclusively on it [32].

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