

# Systemic Decision Support in a Complex Business Environment

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## ABSTRACT

This paper presents a so-called systemic decision support system (SDSS) to support decision-making in a complex business environment. The approach can be applied by both private and public enterprises and organisations in their long-term strategic considerations. The approach consists of a framework that is adapted to the particular task by combining appropriate methodologies of different type and nature. Both “soft” and “hard” operations research (OR) methods are applied, for example, Critical Systems Heuristics (CSH) and multi-criteria analysis (MCA) making use of Monte Carlo simulation. As argued in the paper, rationality and optimisation as relating to traditional OR methods become difficult to vindicate and validate in complex decision environments, for which reason it is proposed instead by SDSS to assist the decision-makers by providing decision support based on the contrasting of different insights as successive steps in a wider exploration and learning cycle. The systemic approach is illustrated by a practical example that concerns the decision-making relating to the Øresund Fixed Link. Although this concerns one particular problem type: complex public decision-making, the treatment of the example has made it evident that systemic decision support is well suited for complex strategic decision-making in both public and private settings. Finally some conclusions and a perspective are given.

## 1 INTRODUCTION

A characteristic of our emerging hypercomplex society is a still increasing degree of uncertainty and complexity in the various societal sectors (Leleur, 2004). This makes strategic managerial decision-making in both private and public enterprises and organisations a risky undertaking raising thereby a need to develop types of decision support suited for complex business environments. On this basis this paper proposes a so-called systemic decision support system (SDSS) approach that is also illustrated by an application example.

The paper is disposed so that Section 2 gives the main ideas behind the SDSS methodology. In this respect the paradigms of Simplicity and Complexity thinking as set out by the French philosopher of science Edgar Morin are presented and a basic framework is formulated. On this basis the following Section 3 sets out SDSS as a multimethodology approach combining “soft” and “hard” operations research (OR) methods to formulate an exploration and learning cycle that can guide and support

analysts and decision-makers in the concrete application case. Next in Section 4 an application example is dealt with. It concerns the complex public decision whether or not to build the Øresund Fixed Link at a cost of EURO 3.2 billion for road and rail traffic between Copenhagen and Malmö. The case has been treated with emphasis on the general applicability of SDSS. Section 5 finally gives some conclusions and a perspective.

## 2 SIMPLICITY, COMPLEXITY AND SYSTEMIC DECISION-MAKING

In accordance with the English organisations- and complexity researcher Ralph Stacey, change processes in business organisations can be categorised into so-called closed change, contained change and open-ended change (Leleur, 2004, pp. 16-17):

- Closed change: The key features of closed change are unambiguous problems, opportunities and issues, clear connections between cause and effect, and the possibility of accurately forecasting the consequences of change. Faced with such change, people tend to behave in easily understandable ways. The decision-maker can make use of rational decision-making techniques and the processes of control are formal, analytical and quantitative. There is a clear purpose with clear preferences, and alternative ways of achieving the purpose are known.
- Contained change: The key features of contained change derive from those change situations where it is possible to make probabilistic forecasts based on actions taken now and their most likely consequences. This is made possible because the consequences appear to some degree as repetitions of what has happened in the past or they relate to large numbers of essentially the same event. As a manager looks into the future, accurately predictable closed change declines in relative importance, while less reliably predictable contained change increases in relative importance.
- Open-ended change: Control in open-ended situations in practice means something completely different from what it means in closed and contained situations. In such situations, the future consequences are unknown and forecasting is totally impossible due to an ambiguous purpose and equivocal preferences of the actors involved. The whole situation being confronted is ill structured and accompanied by inadequate information more or less subjective and conditioned by personal ambitions, beliefs and values. There are problems with interpreting data and applying statistical techniques in uniquely uncertain conditions, for which reason forecasting and simulation become problematic.

Decision support systems (DSS) can in many cases be reasonably well specified and developed so they can facilitate managerial decision-making relating to closed and contained change, whereas open-ended change remains a challenge for several reasons. One basic consideration in this respect is that the uncertainties involved in complex decision-making are principally of a generic type that cannot be satisfactorily dealt with by detailing and refining the DSS methods that work well in situations with closed and contained change.

The application of systems science for improving our problem-solving capabilities holds two promises (Ibid., p. 22):

- By seeing our problem or study object as a system we may make use of the systems concepts to make a better representation of it and here capture (and model) various *interrelations among elements*, etc. in a more qualified way.
- By seeing our problem as a system we may be able to focus less on step-by-step approaches and capture more *holistic impressions* which can qualify our study.

The first statement concerns what is sometimes referred to as systems analysis. In an almost generic process we commence by defining our problem and determining the objectives. After this we turn to envisage or model the consequences of various alternatives being relevant. Then we appraise the alternatives to make it possible to select the best one. The final step concerns the implementation of this alternative and possibly it may be decided to continue the process by monitoring it (Leleur, 2000, p. 18). Our ideal in this undertaking is to be rational in our decision-making so the analytical processing of complete information will lead to an optimal result, be it a decision, design, plan, etc. We will see this as a *systematic approach*.

The second statement above relating to the use of systems science, expresses that wholeness matters and it can therefore be seen as a corrective to the first one. With the systematic approach we proceed in our problem-solving by using a step-by-step approach; with the *systemic approach* we are concerned with holistic views.

No doubt the systematic approach is tied to rational-analytical thinking well-known to people educated, for example, as engineers and economists whereas systemic as notion is more difficult to understand and come to grips with. In this situation the so-called paradigms about Simplicity and Complexity are highly relevant, where a paradigm denotes a specific research pattern. On this basis Morin sees classic scientific explanation as based on a Simplicity paradigm. Although he recognises the strength of the Simplicity paradigm in many respects, he also sees certain limitations in its explanatory models. As physics and cosmological thinking have always been major suppliers of ideas to other branches of science, it is interesting that subnuclear physics is the major example that Morin uses to explain the insufficiency of the Simplicity paradigm as it cannot satisfactorily explain new so-called exotic particles for example. Against this background Morin proposes a so-called Complexity paradigm to widen our research pattern by adopting principles that are *complementary* to those contained in the Simplicity paradigm. In Table 1 Morin's two paradigms are indicated by paired keywords (Leleur, 2004, p. 24).

**Table 1**

The two paradigms about Simplicity and Complexity.

Simplicity paradigm	Complexity paradigm
Universality	Multiplicity
Determinism	Organisation
Dependence	Autonomy
Necessity	Possibility
Lawfulness	Self-organisation
Prediction	Surprise
Separation	Wholeness
Identity	Individuality
The general	The particular
Objects	Subject
Elements	Interactions
Matter	Life
Quantity	Quality
Linear causality	Multi-causality
The automaton	Time
Objectivity	Culture

As concerns the development of systemic decision support we will see systemic thinking as rooted in the Complexity paradigm and systematic thinking as rooted in the Simplicity thinking. The idea is not to replace systematic thinking with systemic thinking but to make wider analysis possible by applying

both. As the conventional approach is tied to systematic thinking we adopt the term systemic for such wider analysis which includes both systematic and systemic findings and not just the latter.

Another basic complementary relationship behind SDSS concerns scanning vs. assessment. Dealing with problem-solving, exploration and learning will depend on a kind of alternating between these two modes, i.e. they cannot be problematised at the same time but they will reciprocally influence each other. Cross-referencing these two pairs of complementary relationships we obtain the basic structure behind SDSS, see Figure 1 (Ibid., p. 127).

SDSS structure	Systemic	Systematic
Scanning	Example: Critical systems heuristics	Example: Scenario analysis
Assessment	Example: Futures workshop	Example: Multi-criteria analysis & simulation

**Figure 1** The SDSS structure as four interrelated modes of exploration and learning. In the figure different methods are indicated to illustrate some possible method choice, see Section 3.

### 3. THE SDSS APPROACH TO SYSTEMIC DECISION SUPPORT

The SDSS approach is developed by making use of the generic structure shown in Figure 1. Generally this is done by applying appropriate OR methods, see Table 2, in a self-organising process that embeds conventional optimisation in a wider process of exploration and learning (Ibid., p. 35). The on-going search-learn-debate process moves on by contrasting and interpreting the different findings and insights. The process aims at converging into a satisfactory end result for the decision-makers.

**Table 2**

The OR tool box to be applied within the SDSS

Some current OR methods available for SDSS: Bold types indicate methods applied in the example	
Analytical hierarchy process (AHP) Computer-aided design (CAD) Conflict analysis Cost-benefit analysis (CBA) and cost-effectiveness analysis (CEA) <b>Critical Systems Heuristics (CSH)</b> Critical path method (CPM) Cross-impact analysis Decision analysis (DA) applying SMART and SMARTER Delphi conferencing techniques Environmental impact assessment (EIA) Expert systems Forecasting <b>Futures workshop (FW)</b> Fuzzy set theory Game theory Graph theory Input-output analysis	Interactive planning (IP) Intuitive exploration/brainstorming/metaphor and analogy building Linear programming techniques <b>Multi-criteria analysis (MCA)</b> Multiple perspectives (MP) Network theory Optimisation theory and heuristics Program evaluation and review techniques (PERT) <b>Scenario building</b> Sensitivity analysis <b>Simulation</b> Soft systems methodology (SSM) Statistics, probability and queueing theory Strengths, weaknesses, opportunities and threads analysis (SWOT) Systems dynamics Total systems intervention (TSI)

Generally “hard” OR methods can be seen to provide so-called first-order findings based on calculative rationality whereas second-order findings (or even higher) are associated with “soft” OR methods – based on communicative rationality - that relate to the so-called subworld created around a

complex problem by the various stakeholders and participants in the process (Ibid., pp. 72-73, p. 107). The wider process adapted with SDSS makes it possible to deal with the complex problem in a much more explicit way. The example below describes some findings relating to the Øresund Fixed Link. (Ibid., pp. 132-136).

#### **4. OVERVIEW OF APPLICATION EXAMPLE**

The Øresund Fixed Link – open since July 2000 – can be regarded as one of the most complex transport investment decisions made in Scandinavia (Rønneest et al., 1997) (Leleur, 2004). The case work demonstrates how the huge amount of information produced in studies, etc. over the years could have entered an ex-ante examination applying the SDSS approach. In this respect the case has functioned as a kind of evaluation research methodology laboratory (Decision Modelling Research Group, 2004).

The OR methods made use of are, see Table 2: critical systems heuristics (CSH), scenario analysis (SA), futures workshop (FW), multi criteria analysis (MCA) and simulation (SI). In brief the CSH mapped decision coalitions (“players”) and their motives and different responses at certain stages whereas SA and FW provided a set of interrelating framework- and trend scenarios. These were followed by MCA and SI. An intermediate result in the exploration and learning cycle was for a central scenario (medium integration in the Øresund region & EU-wide regulative economy and sustainability) a total rate of return from the investment based on discounted assessment of all benefits and costs equal to 0.85 (95%-percentile), 1.03 (50%-percentile) and 1.15 (5%-percentile). This led to various reconsiderations of decision criteria and uncertainties. The overall analysis shows, among other things, that feasibility including strategic concerns about mobility, trade, employment, etc. depends on follow-up issues by the different stakeholders that can ensure integration in the Øresund region in various ways: trade, employment, firms adopting better logistics, etc. (Ibid.).

#### **5. CONCLUSIONS AND PERSPECTIVE**

The limited space only allows an outlining of the major characteristics of SDSS together with an overview of some of the results from an application case. Even on this basis it can, however, be concluded that SDSS holds a potential as guidance for providing decision support of particular relevance for open-ended, complex business or societal problems. The demand of such methodology with a still increasing complexity in society in general and in the professional spheres of administration and business more specifically, combined with the flexibility and adaptability of SDSS, makes it relevant to pursue a further development of the current SDSS principles, methodology and IT & software. Upcoming events and activities in this respect involving the Decision Modelling Research Group (DMRG) at the Technical University of Denmark is a book to be published about systemic planning (Leleur, 2004) and a section at the DMRG website with various relevant information, for example, concerning the OR tool box and the methodology principles and sources. Furthermore, SDSS will be a topic area at an Evaluation Methodology conference arranged by DMRG in November 2004 in Copenhagen as part of the group’s research activities in the Danish Centre for Logistics and Goods Transport (CLG).

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