



PUBLIC DECISION SUPPORT

- USING A DSS TO INCREASE DEMOCRATIC TRANSPARENCY

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Abstract

We present a case study in which a decision support method (ADL) was employed by a local government in order to guide and aid decisions on three complicated and politically infected issues which had remained unresolved for many years. The research inquiry was whether a well-defined and openly accessible method would aid a common understanding of the decision problems, and whether people would be able to accept a clearly motivated decision even if politically they preferred a different option. The ADL method has been used in several public sector projects ranging from very large purchasing decisions to the selection of national policies, but this test case was novel in that it involved close inspection by the public. This case was also devised as a test of new methods for potential inclusion into normal practices. The post-case analysis shows mixed understanding of and belief in the method. The results raise issues concerning both the potential for decision support methods in a political context and the nature of political decision making.

Keywords: Decision support, multi-criteria decision analysis, democratic decision process, e-Democracy

1. Introduction

The case discussed in this paper includes a set of three complicated, and related, decisions to be made by the politicians in Nacka, a medium-sized municipality (approximately 75,000 inhabitants) on the outskirts of Stockholm. The project was a joint collaborative effort between the municipality of Nacka (the problem owner), researchers from the DECIDE Research Group, a consulting company specializing in the public sector acting as process support, and an independent investigator evaluating the results post-case.

The paper consists of three parts. The first part presents the decision problems faced by the local (municipal) government and a background to DSS use in e-democracy. The second part discusses the decision support system (ADL) used in the case. The outcome of the decision process was subsequently investigated by an independent researcher, who had taken no part in the execution of any step of the process. The last part contains the results of the post-case investigation into the effects the ADL method had on the decision process and its participants.

2. The Problem

The municipality of Nacka belongs to the Greater Stockholm Area and parts are situated in the inner Stockholm archipelago. Two of the islands within the Nacka borders are Älgö and Gåsö. Älgö is closer to the mainland and is connected to it by a bridge. Gåsö is just beyond Älgö and only accessible by boat. Although originally inhabited in the main by summer residents (the fishermen lived further out), some of the islands, particularly those that are easily accessible by either car or commuter boats, the summer houses have now evolved into permanent residences. This is particularly true of Älgö, with Gåsö having fewer permanent residents. The proximity to Stockholm has made property prices surge, so on islands such as Älgö (and to some extent Gåsö) expensive houses built by relatively affluent newcomers now neighbour older houses inhabited by residents who have been there for generations. This influx of permanent residents into the areas has raised demands for public services such as roads, water supply, and sewers, and also for marinas to facilitate commuting to islands inaccessible to cars.

Until now, such facilities had been run cooperatively by the inhabitants, but according to Swedish municipal law, permanent residential areas in Sweden require the municipality to take over responsibility (although not necessarily operation), both by public demand and by law (not the marinas). For almost a decade, the debate regarding the issues concerning whether the above-mentioned services should remain in private hands or be run by the municipality had been on-going. Inhabitants of Älgö were divided into two opposing groups with reference to the road, water and sewers issues, but who were united in a dispute with Gåsö inhabitants over the issue of the location of a commuting marina. All groups had lobbied politicians for many years.

Swedish law requires prospective real estate owners to apply for permits for every planned building. However, the municipality has the ability to postpone a permit application for only two years, after which it automatically passes without alteration, thus creating a planning chaos. Permit applications can only be altered or turned down provided that specific plans for the area exist and have been accepted by local government. In Älgö, time was running out since the backlog of postponed permit applications was reaching the two year limit. Thus, time pressures were facing the politicians with regards to a set of three difficult decisions concerning the Älgö area:

- A new water and sewage system
- A new road plan
- A new commuting marina

The decisions had been postponed on several occasions over the preceding seven years and were labelled “infected” by some of the stakeholders.

There were political parties in the local council supporting both factions in Älgö. The Green Party generally supports “local solutions” while the Social Democrats typically prefer municipal-wide systems. The Conservatives and the Liberals – the coalition in power at the time – did support private entrepreneurship, but were divided in this case as they had also made investigations showing that a publicly owned system would in the long run be more economical. The Social Democrats are generally in favour of municipal ownership. All parties had a sizeable number of voters on the islands and since the reigning coalition was not very strong, any change in voter preferences could prove fatal in the next municipal election. Thus, there were compelling incentives to solve the decision problems, but realities notwithstanding, the process had come to a grinding halt on several occasions over the preceding years.

After having failed for so long to reach decisions, it was felt that a new angle had to be explored. In 2003 the leading civil servant at the Municipality Planning Office was made aware of the option to use a decision support system (DSS) for political public decision making. As this is a new setting for DSS, potentially requiring additional support and/or other considerations, we henceforth use the term public decision support system (PDSS). The DECIDE Research Group and the consultants became involved in a renewed attempt to finally achieve a satisfactory solution to the decision problems both democratically and economically. The Älgö decision process (including all three decisions to be made) in this novel format was run for six months during the winter and spring of 2004 with a proposed decision date in June 2004.

This paper concentrates on the process of handling all the information and creating decision support information understood and agreed upon by all participants in the Älgö project. Thus, it focuses on the workings of the PDSS as a tool and facilitator of a common process in a political decision support situation.

3. Decision Support in e-Democracy

The field of e-democracy, often named e-participation, has approached the problem of improving democratic decision making by emphasizing the encouragement of broad participation [Grönlund 2003b]. Experiences so far show that while the use of electronic tools in local contexts in combination with redesigned democratic processes have indeed affected participation positively, both scaling and quality requires more sophisticated technical tools of at least two types. One, recognized by the e-democracy community, involves tools supporting cooperative work for facilitating communication among humans [Ranerup, 1999; Aurigi, 2000; Musso et al., 2003; Macintosh, 2001]. Another provides for more formal problem modelling. The e-democracy field has so far almost exclusively been concerned with encouraging and, at best, modelling, moderating, and reviewing discussions. Experiences from, e.g., citizen juries, point to the importance of expert participation. DSSs could provide mediated expert participation in virtual groups and in communication with the public. To achieve this, there is a need to carefully consider both the usability of DSSs and their role in the overall democratic system.

In the literature concerning (e-)participation and trials, such as the case reported here, there is ample discussion about democracy and participation. Both concepts are problematical, and no single best solution exists as to how to organize processes to become “better”.

As for participation, the role of the elite and the public, and the role of politicians and administrators respectively, are topics discussed extensively [Pateman, 1970; Sartori, 1987]. In the field of e-democracy, three aspects of participation are discussed: (i) with the general public, (ii) among politicians, and (iii) politicians vs. administrators [Snellen, 1995]. These three contexts for participation are quite different, and hence both technologies and methods to support them should be expected to be different. It is however not obvious that systems used in one context can readily be transferred to another. Most DSS applications are designed for context (iii), while most e-democracy trials focus on context (i). Context (i) differs from context (iii) in terms other than merely the number of people involved. There is also a theoretical disagreement concerning just how the general public should be involved. There are many different models of democracy each having different views concerning participation. The case described in this paper addresses all the contexts.

The concept of democracy is itself problematical. Table 1 below summarizes three general model categories containing different views concerning public participation and how ICT (information and communication technology) should be used. Many of the e-democracy trials are based on the *strong model*, focusing on using ICT for discussion. Within the e-government field, on the contrary, the rationale is most often the *thin model* where the focus is on using ICT to inform the citizens. Finally, the *quick model* draws on opinion polls to sense the public opinion and bases decisions on those measurements. Direct democracy is a rough synonym. One of the characteristics of the Älgö case is that it tries to bridge the gap between strong (participatory) and thin (representative) democracy by means of a DSS tool.

	Quick democracy	Strong democracy	Thin democracy
Goal	Sovereignty of the people	Autonomy	Individual freedom
Base for legitimacy	Majority decision	Public debate	Accountability
Citizen role	Decision-maker	Opinion former	Voter
Representatives' mandate	Bound	Interactive	Open
Focus of IT use	Decision	Discussion	Information

Table 1. Dimensions of democracy ([Åström, 1999], authors' translation)

Depending on which model of democracy is preferred, the roles of different actors develop differently at different stages in the overall decision making process.

3.1. The Democratic Decision Making Process

Democratic decision making can generally be illustrated by a policy making cycle model, used by both the OECD and the UK Cabinet Office, which includes five main stages [OECD, 2003]:

1. **Agenda setting:** establishing the need for a policy or a change in policy and defining what the problem to be addressed is.
2. **Analysis:** defining the challenges and opportunities associated with an agenda item more clearly in order to produce a draft policy document. This can include: gathering evidence and knowledge from a range of sources; understanding the context, including the political context for the agenda item; developing a range of options (including doing nothing).
3. **Creating the policy:** ensuring a good workable policy document. This involves a variety of mechanisms which can include: formal consultation, risk analysis, undertaking pilot studies, and designing the implementation plan
4. **Implementing the policy:** this can involve the development of legislation, regulation, guidance, and a delivery plan.
5. **Monitoring the policy:** this can involve evaluation and review of the policy in action, research evidence and views of users.

This is recognized to be a cyclical process in which agenda setting for each round is based on the outcome of previous rounds. The different democracy models point to different roles for public participation, and, as a consequence, different roles for a PDSS. As for the role of public participation, in the strong model, the public should be engaged at all stages. Often, e-democracy proponents find reasons to engage the public in a variety of ways at every stage. In the thin model, on the contrary, the public is typically consulted only at the policy creation and monitoring stages. The *agenda setting* is a matter for politicians, and the (technical) *analysis* is done by experts in the administration. At the *policy creation* stage, the public may or may not be consulted for endorsement, and occasionally selection of alternatives, e.g. by a referendum. Usually, at this stage plans are simply made public and left to the press to scrutinize. Sometimes, rules are available for a formal feedback process to take place. The *implementation* stage is a matter for the administration. Individual citizens will be involved, but only to the extent of helping the implementation proceed – some people may have to be relocated, some compensated for loss of quality of life, e.g. a noisier environment, etc. At the *monitoring* stage, the public may or may not be finally consulted through, for example, questionnaires with questions such as: “What do you think of the quality of the public schools in the area?”

In the thin model, the place of a PDSS is typically at the analysis stage, and hence it is a tool for the administrators. However, there may also be a role for it in the interaction with the public. In the thin model, the role in the interaction with the public is as a pedagogical tool, to inform and explain the reasons behind a certain decision. Some expert or group of experts use the actual system and arrive at a “best” solution. This solution is presented and rationalised using the models, criteria, and preferences used to arrive at that solution. This would happen during the policy creation stage.

In the strong model, on the contrary, the role of PDSS would be rather as an interactive tool to facilitate public discussion. The system would be used publicly, people would be invited to alter the weightings given to certain criteria and explore

the effects of different preferences. This would be initiated by at least the analysis stage. Under this model, its use according to the thin model would be seen as an improper power balance – the powerful tools should not only be in the hands of one group, as this would unfairly give rhetoric power to that group of people.

As this discussion suggest, the role of a particular system may be quite ambiguous depending on how the process in which it is embedded is designed and conducted. Looking at evaluations of e-democracy trials (e.g. [Macintosh et al., 2001, Macintosh, 2003; Wilhelm, 2000; Ranerup, 1999; Öhrvall, 2002; Grönlund, 2001]), they are in fact rather few in number and are somewhat inconclusive. They suggest that there are limits to current procedures, including:

- Web information is static and represents only one view, alternatively a user has to visit multiple (campaign type) sites and digest information that is not using a common format and hence is very hard to compare. Hence, problem modelling is confusing, at best, on the user's part.
- Goal-oriented discussions are hard to pursue. Electronic discussions are unstructured, hard to scale, hard to monitor and analyse, and hard to make use of in a credible way. This is one likely reason why they are typically found to be shallow ([Wilhelm, 2000; Öhrvall, 2002]). Notably, the issue of representativity is a problem, but also summarizing and aggregating discussions is hard to support technically as well as procedurally.
- The role of participation is unclear from a perspective of democracy theory.

The design of ADL InterCom, and the Älgö-Web (see below) in particular, aimed at being clear and interactive, with dynamic content being continuously submitted by multiple stakeholder groups, thus encouraging active participation. Furthermore, some of the problems in the above list have not so far been addressed at all within the e-democracy debate:

- Formal problem modelling.
- Modelling consequences of applying certain preferences.

These are two of the issues the Älgö project wanted to address. In that respect, the Älgö case can be considered as a rather innovative e-democratic trial.

4. The PDSS

The PDSS employed in the case was the Analytic Decision Layer (ADL) method, which consists of two main parts. The *interaction part* (the ADL InterCom) contains the communication channels directed towards the stakeholders; in this case the citizens of the municipality. The *decision process part* (the ADL Process) consists of a three-layered working process model carrying the decision from problem issue to solution.

4.1. Interaction

The Älgö project was run in accordance with practices in Nacka. This allowed any citizen to access information from the municipality, read council board reports, a.s.o. This is in accordance with the Swedish law of public information by which almost every authority's written documentation has to be publicly available.

In addition, the project was highly visible on the web. Citizens were encouraged to submit material to the working process of Project Älgö. The submitted material was used in the decision process and also displayed on the Project Älgö website (the Älgö-Web). All intermediate results of the project group, such as consequence analyses or sets of criteria selected, were continuously published on the Älgö-Web. In the Älgö case, the entire ADL method implementation consisted of:

- The Älgö-Web; web-site for all documents from government and stakeholders.
- E-mailboxes for interaction with citizens in Nacka.
- A newsletter which continuously reported on all progress and problems.
- The ADL process for preparing and carrying out the decision.

As was shown by the post-case investigation (see Section 7), the communication part was less controversial and less determinate. Thus, this paper will mainly discuss the ADL method and its implications on the decision making process.

4.2. The Decision Process

The guiding steps of the overall decision process were to provide:

- A description of the alternative options available
- A description of the criteria (perspectives) under which to view the alternatives
- A description of the consequences of each alternative w.r.t. each criterion
- A procedure that can evaluate and compare the alternatives, taking all relevant criteria into account while aiming at transparency and cost efficiency

The Analytic Decision Layer process (ADL) is designed to meet such requirements. It contains a proven decision analytic method as its core and a layered process to execute the decision steps appropriately. It has been used previously in public decision making, for example in a large decision problem involving many stakeholders, viz. the design of a public-private flood insurance system for Hungary [Ekenberg et al., 2003]. That project was a multi-stakeholder policy decision problem and involved IIASA (the Institute of Applied Systems Analysis) and the Hungarian Academy of Science. The stakeholders included, among others, the public in the high-risk and low-risk areas, the insurance companies, and the government. The design of the nation-wide insurance system involved handling imprecise information, including estimates of the stakeholders' utilities, outcome probabilities, and criteria weightings. The methodology used was a general multi-criteria, multi-stakeholder approach, which included a decision tree evaluation method integrated with a common framework for analyzing decision situations under risk involving multiple stakeholders. The results from the project include a national policy plan for a flood insurance system currently being processed by the Ministry of Finance in Hungary. While being on a much larger scale, the working process including the public information, stakeholder groups and evaluation workshops are also applicable to public decisions at the municipality level. The new component not previously tested is the political element present in the case in this paper.

The ADL process is based on the Delta decision method [Danielson and Ekenberg, 1998; Danielson, 2004]. The method has been used and validated in several decision projects ranging from deposition of spent nuclear fuel in Sweden, over large purchasing decisions at the Swedish Rail Administration (around 1 billion Euro) and investment analyses [Danielson et al., 2003], to the aforementioned Hungarian study.

The method has been packaged into a decision tool that accompanies the process [Danielson et al., 2003b].

4.3. Process Layers

The work was carried out at three different levels called *layers* in the method. There was an outer, semi-political stakeholder process, a middle layer investigation process, and an inner loop containing the decision process. There were continuous interactions between the process layers.

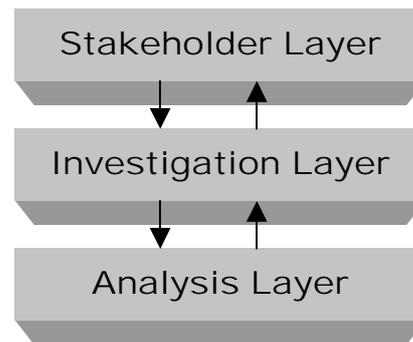


Figure 1. Layered decision process

The *stakeholder layer* contained the political process and the interaction with the citizens. In the Älgö case, the political process itself was rather traditional, including preparation of material in working groups and involving representatives from the political parties elected to the local parliament. The strong interaction with the citizens through Internet communication channels was a novel component, not previously attempted in this setting. This was the layer where the goals were set and later measured.

The *investigation layer* consisted of the administrative process of the local government during which civil servants made the investigations and assessments necessary for carrying the process further. They were responsible for processing the information from the stakeholder layer, i.e. the views of the citizens and of the political governing council of Nacka. Further, they took all facts available into account, ranging from environmental reports to laws controlling the various means by which plans can be implemented. This was the layer where most of the structuring took place along with the processing of the information obtained into decision data.

The *analysis layer* consisted of a decision analytical process carried out in a number of steps. The initial information was gathered by the investigation layer from different sources such as previous investigations and information submitted by the citizens. Then the information was formulated into statements and entered into the decision loop layer. Following that, an iterative process began where, step by step, the process participants gained further insights. During this process, the participants received help from the formal decision process as to whether the information collected was conclusive or not and if not, which parts should be improved. They also changed the problem structure by adding or removing consequences and even entire alternatives, as more information became available. The inner loop process in the analytical layer that drives the entire ADL process is shown in Figure 2.

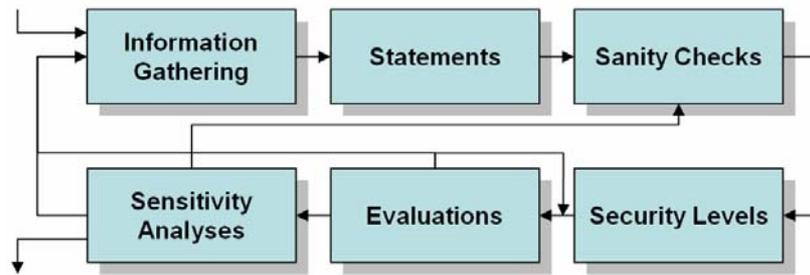


Figure 2. Decision analytic process

The function of the decision analytic layer as the driver of the PDSS process can be seen as every step of the process contains elements from all three layers.

4.3.1. Information Gathering

The first information collection phase was a large step since the problem was complex and the different views were sometimes hard to obtain in a common format. For Project Älgö, it took several man-months to perform. Also, the project web, “the Älgö-Web”, had to be designed and deployed. Information from citizens had to be collected by all available means. Information was entered from politicians as well as from citizens. The project goals and guidelines were given by the political agenda for the Council. This was received by the investigation layer and transformed into plans and schedules. Information from citizens was taken into account when collecting information on the various possible alternatives and consequences.

4.3.2. Modelling

After the information collection phase, a modelling task commenced at the investigation level, where the participant group both structured and ordered the information for Project Älgö. The first sub-task was to describe the available water/sewage solutions. The descriptions of the alternatives had to be comparable with each other. The alternatives considered at this stage were from the following categories:

- The Council’s centralized solutions
- The Council’s localized solutions
- The alternatives from lobby groups in Älgö
- A zero action alternative – no decision made

The alternatives were not described in detail. Rather, it was the primary goal at this early stage to make the alternatives intelligible to the vast majority of all interested citizens. It was not even a requirement at this stage that the alternatives were actually possible to implement in full detail. During the entire decision process, citizens were encouraged to submit views and supply additional information into the process, forming a feedback loop. The same procedure was repeated for the road and marina decision problems.

4.3.3. Criteria

For each decision, each alternative contains a number of consequences. These consequences are bundled together into criteria. Examples of criteria include:

- Cost

- Environment
- Health
- Real estate value
- Fairness

5. The Analysis Layer

There are several candidates for the computer tool in the ADL analysis layer. The decision problems faced were multi-criteria, multi-stakeholder problems involving decision making groups with differing views. Aggregation of utility functions under a variety of criteria is investigated in the area of Multi Attribute Utility Theory (MAUT); see for example [Fishburn, 1970; Keeney and Raiffa, 1976; Keeney, 1992]. A number of techniques used in MAUT have been implemented using computer programs such as SMART [Edwards, 1977], aimed at social decision making, and EXPERT CHOICE, being based on the widely used AHP [Saaty, 1977; Saaty, 1980]. AHP was criticised at an early stage with regards to a variety of aspects [Belton and Gear, 1983; Watson and Freeling, 1982; Watson and Freeling, 1983] and models using geometric mean value techniques were suggested instead [Barzilai et al., 1987; Krovak; 1987]. Techniques based on the geometric mean value have, for instance, been implemented by Lootsma and Rog in REMBRANDT [Lootsma, 1993].

All these tools have their respective advantages, but a requirement to provide numerically precise information is often unrealistic in public decision support situations. Some models with representations allowing imprecise statements have been suggested in the literature. For instance, [Salo and Hämäläinen, 1995] extends the AHP method in this respect and makes use of structural information when the alternatives are evaluated into overlapping intervals. The system ARIADNE [Sage and White, 1984] also allows the decision-maker to use imprecise information, but does not discriminate between alternatives when these are evaluated into overlapping intervals. This is often the case when group member views are merged together, and is a necessary function to handle in ADL.

Furthermore, fuzzy set theory is a widespread approach to relaxing the requirement of numerically precise data by providing a more realistic model of the vagueness in subjective estimates of importance weights and values [Chen and Hwang, 1992; Lai and Hwang, 1994]. These approaches allow, among other features, the decision group to model and evaluate a decision situation in vague linguistic terms. However, the unfamiliarity among the politicians and stakeholders with the concepts of fuzzy set theory made the local government reluctant to commit to such a representation. The accountability issue was one of the reasons to conform to classical statistical theory rather than to fuzzy set theory. By doing so, the project avoided difficulties in the acceptance of the ADL approach, taking into consideration that all decision steps must be accepted and understood by the local government itself as well as the representatives of the interest groups.

5.1. Decision Frames

At the analysis level, a *decision frame* represented each decision problem. The idea behind such a frame is to collect all the information for the model from the investigation layer in one structure. This structure was then filled in with user statements. All the criteria (perspective) weight information (intervals or comparisons) in each of the three decision problems shared a common structure because they were all made relative to the same decision frame. They were translated

from the investigation layer and collected together in a *weight base*. For value statements, the same was done in a *value base*. The correspondence between the user model in the investigation layer and the representation in the analysis layer is summarized in Figure 3.

Investigation layer	Analysis layer
Decision problem	Decision frame
Alternative	Consequence set
Consequence, event	Consequence
Collection of statements	Constraint set (base)
Comparison between two values	Inequality involving value variables
Comparison between two weights	Inequality involving weight variables

Figure 3. Representation in different layers

A decision model of the situation was created with perspectives, relevant courses of action, and their consequences when specific events could occur. The model was then represented in the analysis layer by a decision frame. The courses of action were called alternatives in the investigation layer, and they were represented by consequence sets in the decision frame in the analysis layer. Following the establishment of a decision frame in the support tool, the probabilities of the events and the values of the consequences were filled in as data as moved into the analytic layer. A multi-level tree as it appeared in the tool is shown in Figure 4.

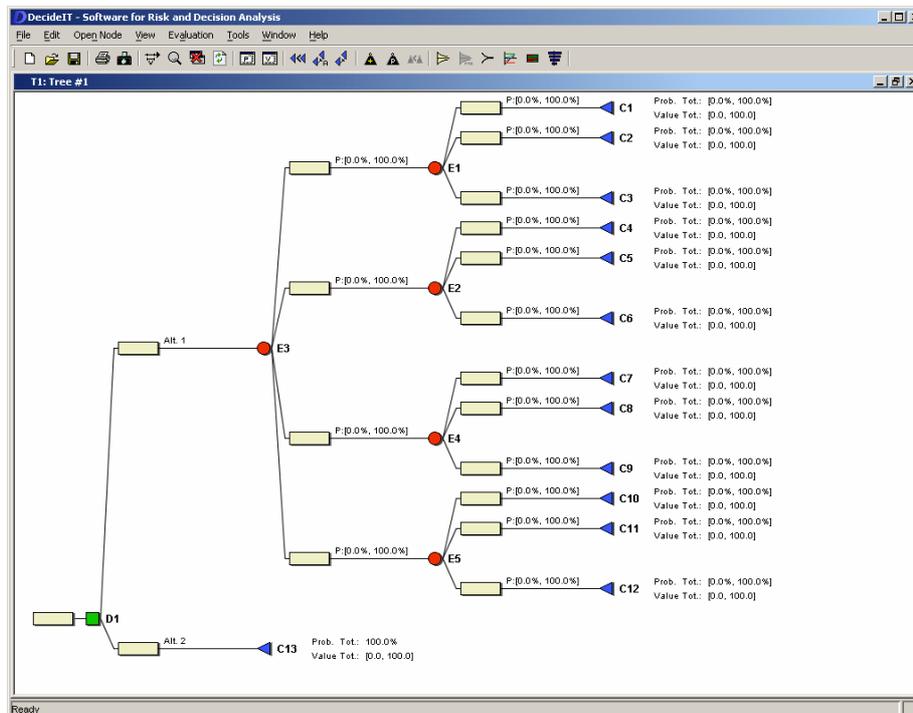


Figure 4. Representation in different layers

5.2. Group Data

The elicitation work in the group of political decision-makers was performed as follows. Initially, each of the decision-makers participating in the process was asked to rank or weight the criteria according to their individual preferences (and political standpoints). They were each given a total importance mass of 100 to distribute over the criteria. For each alternative, an interval was then formed including all decision-makers' statements. This interval represented the group's importance view, and thus, subjective information and viewpoints in the form of political values were considered.

Next, when all the alternatives were thoroughly investigated, the results, described as consequences of each alternative with respect to the criteria, were handed over to the decision-makers, who were asked to value each alternative under each criterion on a scale from 0 to 10. Thus, one value profile was created for each participant. The group members were allowed to adjust their importance rankings before the analyses began.

From the individual value profiles, a *group value profile* was then formed in the following way: For each alternative under each criterion, an interval was formed including all decision-makers' statements. For example, if – for a particular alternative under a criterion – the decision-makers' values were 1, 4, 5, 6, 6, and 8 respectively, then the interval was [1, 8] and the focal point (the most representative point) was the mean value, in this case 5. The interval and the focal point represented the group's valuation of that particular alternative under a certain criterion (perspective).

A similar profiling was then made for the ranking weights, *preference profiling*. For each criterion, all individuals' distributions of weights were collected together by forming an interval embracing all weights. As for the values, a focal point was formed from the mean value of the weights. This was the group's ranking of the importance of the criteria. In addition, subsets of the individuals' weights could be collected together in preference profiles w.r.t. political standpoints. These are then called *coloured preference profiles*, for example a red (socialist), a green (environmentalist), and a blue (conservative) coloured profile.

6. Evaluation

Thereafter, the project work continued at the analysis layer with the evaluation of the alternatives. The analysis of the alternatives began as soon as they were entered. As the first evaluation step, the *sanity* of the decision frame was checked. Much of the information collected, particularly in a large project such as this, is at risk of being misinterpreted during the process. When some data in the frame proved to be problematical, the investigators would consider leaving it out of the current cycle or recollecting it, i.e. sending it back to the investigation layer. Missing data was handled in that layer for later inclusion in the analytic model. For example, a missing consequence was added at a later stage in the process. If the set of consequences for some alternative was not exhaustive, a residual consequence was temporarily added. It is a feature of the tool to be able to handle imprecise, missing, or vague information. Such possibilities had certain advantages as the results emerging at the outset of an evaluation could be viewed with greater confidence than if erroneous data had been entered.

6.1. Security Levels

Many decisions are one-off decisions, or are important enough not to allow a too undesirable outcome (consequence) regardless of its having a very low probability [Danielson, 2004]. This is why the project could not rely entirely on maximizing the weighted (expected) value. The common aggregate decision rules in the analytic layer did not rule out an alternative with such a consequence provided it has a very low probability. This was solved as follows. If the probability for a very undesirable consequence was larger than some *security level*, it seems reasonable to require that the alternative would not be considered, regardless of whether the weighted value showed it to be a good course of action. If the security level was violated by one or more consequences in an alternative, then the alternative was *unsafe* and should have been disregarded. An example of security levelling in selecting a road plan is when a local government would not desire to enter into a situation where the overall plan is attractive but there is a small, but not negligible, risk for the outcome to be roads which are too narrow, thus not allowing rescue vehicles to pass speedily and safely, consequently endangering the effectiveness of rescue operations. The concept of security levels was an important supplement to the weighted value. A security level setting would, for example, prohibit instances where roads unfit for rescuing people and property could be built.

6.2. Weighted Value

After having taken security levels into account, which value does a particular decision have? It seems natural that the value of the decision should be some kind of aggregation of the values of the individual consequences. The basic comparison rule of an evaluation in ADL (as well as in many other systems) is the weighted value (W), sometimes instantiated as the expected value. If neither weights nor values are fixed numbers, the evaluation of the weighted value yields quadratic (bilinear) objective functions to be optimized. See [Danielson and Ekenberg, 1998; Danielson 2004] for a discussion on efficient algorithms for such evaluations. The outcome of an evaluation rests on the *goodness* of the alternatives.

- The alternative A_1 is *at least as good as* A_2 if $W(A_1) \geq W(A_2)$ for all consistent assignments of the weight and value variables.
- The alternative A_1 is *better than* A_2 if it is at least as good as A_2 and further $W(A_1) > W(A_2)$ for some consistent assignments of the weight and value variables.
- The alternative A_1 is *admissible* if no other alternative is better.

If there is only one admissible alternative it is obviously the preferred choice. In this project, more than one alternative for each of the three decisions were admissible, since apparently good or bad alternatives were dealt with on a manual basis before the PDSS was brought into use. All non-admissible alternatives were removed from the considered set and took no further part in the evaluation. The existence of more than one admissible alternative meant that for different consistent assignments of numbers to the weight and value variables, different courses of action were preferable. When this occurred, how was it possible to find out how to carry the analysis further?

6.3. Sensitivity Analyses

After the evaluation, the next step was a *sensitivity analysis*. The analysis attempted to show what parts of the given information were most critical for the obtained results and must therefore be subject to careful additional consideration. It also points to which information is too vague to be of any assistance to the ongoing evaluation. Information identified in this way was subject to reconsideration, thereby triggering iteration in the process.

Sensitivity analyses were initiated from the analysis layer. The analyses were made by reducing the widths of the intervals (contraction) for the probabilities, values, and weights in the analysis model of the decision problem. The contraction resulted in a belief cut in the sense that the less believable, more peripheral parts of the intervals were cut off and new evaluations performed. It is reasonable to regard the contraction as an automated kind of sensitivity analysis. Since the belief in peripheral values was somewhat less, the interpretation of the contraction is to zoom in on more believable values that are more centrally located. In the case of two opposing views, i.e. the interval embraces two polarized standpoints, the contraction represents a simultaneous compromise on each part. Whether or not the contraction can be carried out then depends on the respective parts willingness to compromise in this particular instance.

6.4. Analysis Results

Before initiating a new iteration, alternatives found to be undesirable or obviously inferior by other information from the upper layers were removed from the decision process. The stakeholder layer had to confirm the removal. Likewise, new alternatives were added, when the information gathered in upper layers indicated a necessity. Consequences in alternatives were added or removed as necessary to reflect changes in the model. Often a number of cycles were necessary to produce a reliable result.

There had to be compromises made in order to obtain stable results. The compromises were in the form of reducing the intervals of the weights and values. All compromises were recorded for each participant (politician). Since ADL is a decision *support* system rather than a decision *making* system, the recorded compromises are not automatically entered into the decision negotiations. In particular, major compromises must be discussed in order to ensure that the negotiating parties receive a fair distribution of them (if any). Otherwise, the negotiations would have been perceived to have a lack of fairness. The idea behind the PDSS was to fit into the decision making process already in place, enhancing rather than replacing the public / political decision process.

After the appropriate number of iterations had been completed, both the decision problem and its proposed solution(s) in the form of preferred courses of action were fairly well understood and documented (see Section 7). This was then made available to the public decision-makers for discussions and as a basis for decision. It is important to mention that the analysis results only represented advice given, not a decision made. The intention was not to replace the political process but to support it in a structured and analytical way. Anyone interested and who had access to the information could afterwards check, verify, and criticize the decision based on the output documentation, which, because all consequences are clearly presented, shows how all the alternative courses of action were valued. Also, during the decision process, the analysis was open for comments.

Preliminary decisions were made in June 2004 for all of the three decision problems. For two of the three issues, these preliminary decisions were subsequently

ruled out by decisions made at the national political level after the project was finished. This had nothing to do with the project per se, but has affected the views of some of the involved decision process participants and was kept in mind during the post-case investigation.

7. Post-Case Investigation

The post-case question is if, or to what extent, PDSS can be used in issues where opinions are truly mixed, something which is typically the case in politics. One of the ideas concerning a PDSS is that clarity and transparency make the case. In the Älgö case, it was assumed that a strict and open method would clarify the grounds for the decision, and that people would accept a clearly motivated decision even though they personally preferred another solution. In this case no decisions were made on the trickiest issues. Instead political struggle, fired by underlying antagonism among inhabitants, continued. However, many people in the project group still believe that the method has several advantages. As a research problem, this is interesting. DSSs have been used over many years, often successfully, but this has been in less public contexts. Are the experiences transferable – *how, and under what circumstances, can a PDSS support decisions in a political context?* Also the outcomes may be challenged – was the failure to make a decision in June 2004 in fact a success? Did the project lead to a clearer understanding that the problems were to a large extent political and hence only solvable politically? Was this perhaps exactly what the political system needed in order to better fulfil its role – to make decisions where compatibility among all views is impossible and economic calculations do not speak strongly in favour of any proposed solution? [Grönlund, 2003]

The issue of *how, and under what circumstances, DSS can support decisions* is not new, but the application of a PDSS in a *political context* is, and this poses new challenges [Grönlund, 2003]. Closed organizational use of DSS has been in focus for a longer time. Not only are political contexts less controllable than business decision making as the public is involved more directly but, additionally, even though one part of political decision making concerns finding technically sound solutions, politics by definition deals with representation and compromise rather than striving for objectively rational decisions. Further, to a greater extent than in business, social values are involved. Nevertheless – or precisely for these reasons – rational public decision support might be very useful as it could help sort out many technical issues involved in assessing numerous criteria and at least clarify the grounds for decisions for everyone involved or affected. The purpose of the post-case study was to understand how decision-makers involved in the Älgö project understood the PDSS they used, and how they perceived this means of making decisions. Could a PDSS find a place within, and improve, the existing political decision making procedures? Is a PDSS useful, and what can we learn from this case regarding its design and use? All these questions were asked to initiate inquiry into the more general question concerning if, how, and under what circumstances, PDSS can support decisions in a political context.

Interviews were made with the participants in the project group – 4 politicians – three civil servants at the Municipality Planning Office adjunct to the group, and leading officers in four groups who organized citizen interests for the issues involved. Interviews were made by telephone. They were semi-structured by use of key themes, and lasted 45 to 90 minutes each. Notes were taken, spelled out more clearly with inclusion of our interpretations immediately afterwards and emailed to the interviewees for approval and corrections. Some people made minor clarifications,

usually by moderating formulations they used in the interview and by detailing some technical issue.

The key themes investigated were:

- How the interviewee viewed the *process*, including the contacts between decision-makers and the public, the cooperation within the project group, the role of the consultant, and the influence of the method (the PDSS) used.
- The *work* of the individual. This includes, time spent, the view of the different steps such as arriving at decision criteria, weighting of criteria, assessing alternatives, and finding and disseminating information.
- The *method* itself. Requirements for time spent, ease of use and understanding, cost, and added value, and if there were suggestions for improvement.
- The *result*. What was the most positive with the method? The most negative? Was the outcome different to that if a traditional method had been used, and if so, how? How, if in any way, was the planning process affected?

The first three themes are grounded in the extensive DSS literature. There have been a large number of studies on DSS and its use in a variety of contexts. Traditionally, DSS are thought of as a technical system representing knowledge in some way and applying inference mechanisms to that knowledge. Using the Bayesian model, opinions are also represented quantitatively by assigning weights to parameters representing people's views. Holsapple [Holsapple, 2005] provides a modernized definition more in accordance with IS views discussing "human decision support systems (HDSSs) and defines DSS as "*computer-based systems, including those that support individual or multi-participant decision-makers.*" This definition illustrates the evolution of the DSS concept and applications as it also includes the idea of multiple people involved. It also places the emphasis on the DSS' "ability to hold and process knowledge that is of benefit to the decision-maker as he/she drives toward creating knowledge about what to do" [Holsapple, 2005]. Thus, a DSS is not merely applicable to some decision point but is, or should be, a process support. The application of DSS to the political process is new and the result is that both decision-makers are in a different position as compared to the traditional DSS settings in business environments – elected politicians have a fragile position – and that new actors are closely involved if not actually making decisions, i.e. the public. Therefore, theme four above was brought up for the purpose of understanding how the method fits into political decision making as understood by the actors in that field [Grönlund, 2003].

7.1. Findings

Next, findings by the four themes above are briefly presented. (In the following, quotes are coded by CS for civil servant, P for politician, and C for citizen)

The project was somewhat controversial from the outset. The official motivation was that "The situation was so complicated with strong antagonism. We had already used the usual methods but had not succeeded in arriving at a solution" (CS1). Another motivation, less prominent but clearly present, was to test new methods; "this is not the only time something is complicated [and this project should serve] as a pilot test for the future" (P3). To the contrary, all citizen groups thought enough was already known (although their interpretations of the information were diametrically opposed); the only thing missing was the political decision. They considered the new project a

political move to gain time, not motivated by any information need. “Unnecessary! [The project means] the same information is collected once more” (C1).

Technically, there were two main new ingredients in the project. One was the PDSS used, the ADL Process, as the core of the work method. The other was ADL InterCom, a rather extensive use of the Web; all documents were published there, both background information and outcomes of the process such as minutes from meetings and information from interest groups. The interviews show that everyone was positive about the web publication. All agree that it enhanced openness. Not only was Municipality information made more easily accessible (even in traditional procedures it is always public, only more complicated to find), but the local interest groups also had to substantiate their views by facts. It also saved considerable time for the politicians in power, as there were fewer phone calls and less need for long oral explanations. The web also served well as an information source for politicians in the processes. One of the citizen groups was rather critical concerning the quality of some information on the web, in particular that stemming from other interest groups. But this was a minor problem; in general all saw this as increased openness. This generally positive view of the InterCom leads us to concentrate in the following section on the use of the ADL Process as this is a more controversial matter.

1) THE PROCESS. Everyone at the Municipality considered the work in the project to be “different”. Most had positive aspects to mention, even though most were also critical both towards the way the work was done and the result.

As for the contact between citizens and authorities, the use of a consultant meant that new information could be collected. Due to distrust, citizens had not previously passed on certain information to the Municipality Planning Office but, instead, preferred to lobby politicians. This tended to create an information imbalance – different actors had access to different information.

A general view of the process, expressed by everyone but valued differently, was that it led to more focus on facts because values were contained in the criteria and weightings at an early stage. That is, people were generally happy with their initial assigned values and felt the result was in agreement with their views. The positive view of the process faded as national political matters interfered. Participants did not separate views on the process from views regarding higher level events, leading to post-case standpoints discussed in [Grönlund, 2005]. In this paper, we focus on the local process.

2) WORK OF THE INDIVIDUAL. An important issue in municipal decision making involves the resources spent, and staff time is the most important resource. One promise made by a PDSS is a reduction in time spent, as part of the assessment of alternatives can be made automatically. On the other hand, PDSS use may mean new information has to be collected and organized. Assessing time spent in this case is difficult as this was the first time a DSS had been used, which obviously meant initial learning efforts. We tried to differentiate between time spent on learning and using the method and time used gathering and understanding information, but this distinction was not clear to everyone. Most participants stated that working with the method – setting up and attaching weightings to criteria – was not time consuming. There was, however, a marked difference among groups. The part-time politicians have experienced the work being more complicated and time consuming than the full-time ones. The latter find learning the method a “bonus” as part of working with

understanding the alternatives. Nevertheless, a generally held viewpoint is that too much time was spent on the project in total.

3) THE METHOD. Another crucial point is the credibility and the usability of the method – did people understand the process of assigning decision criteria and attaching weightings to them, and did they trust the outcome of the calculations to truly reflect their opinions? The answers to these questions varied considerably.

Everyone who participated in the weighting process stated that they were satisfied with the criteria and the weights they had assigned to them. They claimed to still stand by those (the interviews were made more than six months after the initial workshops), but this claim could not be substantiated to any great extent during the interviews. Some had forgotten what weights they actually assigned, but on the other hand during the (lengthy) process they have not had reason to change them. This gives some support for claiming that the result the method produced did indeed offer a solid foundation in the politicians' minds. On the other hand, two politicians (who declared they still stand by their numbers) and all four citizens stated that they basically doubted the effectiveness of this method of working and claimed that views cannot be expressed by means of exact numbers. Such claims raise doubts as to whether or not they have understood the method, which is based on the idea that no fixed numbers have to be given, instead encouraging imprecise assessments. This also raises another critical point, how well the criteria and weights express the underlying opinions. Responses to the question vary. The view that this means of making decisions may not be entirely plausible coincided with the opinion concerning the issue at hand. Those in favour of the "main" alternatives in the road and water/sewage decisions (municipal takeover) were positive, those against are negative. Those who were positive saw increased rigour not merely in the process but also in their own thinking.

At the citizen organizations, people were somewhat unfamiliar with the details of the method. There was no explanation offered by the Municipality, however some people made their own investigations and learned, at least, about the principles of the method. All were sceptical:

There was a marked distinction concerning views about "how humans think" and how they should think among the "pro" politicians group and the citizens. The distinction concerned whether the human brain's inability to explicitly calculate a large number of factors is an advantage that makes it "human" or a disadvantage that could be remedied by computer support to arrive at better decisions, i.e. whether intuition or modelling and calculation is the best way to improve decision quality. This question could be nuanced to say, how much of our thinking should be formalized? This issue was expressly brought up by several interviewees. Some did not criticize the model, only its application to these types of issues. The judgement of what was appropriate use differed considerably among the interviewees. Leading politicians felt that this project was not going too far whereas other politicians and all citizen representatives felt that it was. The factor distinguishing between those in the yes- and no camps was their original opinion concerning the matter at hand, thus making it difficult to assess the PDSS in isolation from the decision situation. This also raised the question of how much of the inner workings of a PDSS should be explained to the general public.

While the work of assigning weights invoked mixed feelings from a theoretical point of view, the work of assessing alternatives was not contested in principle by politicians but proved to be more practically challenging. Assessing alternatives was to the politicians. This work is traditionally handled by the civil servants and

politicians are usually only given one new alternative to accept or reject (rejection often meaning maintaining an existing alternative). Thus, the availability of alternative courses of action for the politicians created a new dimension to the political decision making process.

Another critical issue for the use of the ADL method was whether or not the weights satisfactorily represented the opinions of the politicians or whether they were produced ad hoc. This was not easy to discover. A test was performed using weights from the first and second workshop to see whether the changes made in the intervening time between would have made any difference in terms of outcome. It appeared that this was not the case as the original alternative would still have been retained as the preferred option. However, this does ensure that the weights were totally reliable. Firstly, the politicians were attempting this for the first time and even though they were allowed sufficient time on two occasions to assign and discuss weights, it was not their standard method of thinking. It cannot be assumed that they thoroughly understood the link between criteria weights and outcome. Secondly, groupthink may occur during the meetings. Thirdly, people may change their views over time, so even if weights were indeed representative at the time they were set, they may not be so six months later. The participants' own opinions showed very clearly that they were happy with their weights in retrospect and that they would assign the same weights again given the same situation.

In conclusion, many people were uncertain about just what the weights meant for the following work in the decision process, and were not entirely comfortable with them. There appears to be a need for some practice with the method. Sensitivity analysis was used to give an understanding about the robustness of the outcome. For the decision problems in the Älgö case, the results were stable modulo the political profile on the set of weights, i.e. given one of the two profiles (left or right), the results were stable under contraction. This was interpreted as the results not being dependent on the exact figures submitted but rather standing for clear political standpoints in the issues handled. For the marina, the result proved to be stable regardless of the political profile. Additionally more than one attempt is required in order to be comfortable with the method.

4a) THE RESULT. The project group had come to a decision on each issue (not to be confused with the formal political decision which was not made due to national interference). These decisions were the same as those advocated by the ruling coalition in the previous year and none of the actors involved had changed their minds during the project. Those in favour of the municipal takeover alternative felt the process had made their case clearer by means of better data and clear decision criteria. Those against did not accept this.

It might appear to be something of a paradox that what felt as a negative outcome could instead be seen as something positive from a somewhat longer perspective. According to several interviewees, the method clarified the role of the politicians – mitigating civil conflicts – and what was not (collecting data). As an example, a citizen from Älgö was affected by the marina decision. He was now – as opposed to previously – quite clear about why the politicians made this particular decision. This was because they had made the criteria “safety for boat commuters” of paramount importance, i.e. the politicians had indeed been clear as to their decision criteria. The citizen, however, did not think so much weight should be attached to this particular criterion. In other words, his values did not coincide with the majority of the politicians. This is, in general, what politics is about – arbitrating among incompatible

values, as opposed to choosing among alternatives that can be ranked objectively. This sets the public decision making process somewhat apart from traditional accounts of DSS. Here lies one complication for PDSS use in such a context – how much detail regarding decisions do politicians want to discuss with citizens? The debate about e-democracy a couple of years ago proved that, if nothing else, the idea of a more direct democracy – more citizen involvement – was not well received by politicians. But in this case, the PDSS served its purpose in clearly pointing to the differences in weights as the source of disagreement.

4b) WOULD YOU DO IT AGAIN? As a definite test regarding their views, respondents were asked if they would use the method again or advise some other municipality to use it. Initially, it appeared that the consensus was negative, although less so for some than for others. This is mainly related to the amount of time they had spent on this particular case.

The answers tended to show that people mix up the decision model and the PDSS with this particular project. They also proved that time is a critical issue and that the next attempt to use a similar model must be arranged over a reduced timescale. This said, at least some of the positive politicians felt learning the actual method was not time consuming but a bonus gained from working with the project. This raises another issue, that of part-time politicians. In the political debate, the problem of having politicians who have little time to involve themselves with complicated issues has long been on the agenda. The associated risk, it is said, is that this increases the power of the full time politicians and decreases the reputation of politics in general as it becomes less of a popular activity and more of a profession. In this case, the PDSS has served to increase the gulf between those who have time and those who have not. A more interesting alternative is probably to consider whether, given a longer perspective scenario and when PDSS use is standard procedure, part time politicians might in fact save time by being able to understand well structured information more rapidly and safely by applying decision criteria.

The civil servant most involved with the project thought that parts of the method might be incorporated with standard procedures, in particular the idea of assessing several alternatives, not just one. This is normally done informally in contacts between the administration and interest groups, but in this case politicians were involved which led to the procedure being more structured and correct.

As we have seen above, there were different views regarding the pros and cons of the method. Trying to grasp the overall process, did the decision process as a whole change in any fundamental way? One issue presented, both as a promise and a threat, was that by using structured decision making methods politics would become more scientific and less about “opinions”. The interviewees brought up some interesting points to feed that debate. Nobody wanted to point to the method as being the source for gaining more thorough knowledge that everyone claimed they had acquired. This was partly because they could not clearly distinguish between the method and the project, and partly because they felt factual arguments, not methodological, should be used.

Everyone agreed on one aspect, that it was good to rely on the method in contacts with the citizens. On the other hand, there was some doubt about how the PDSS and the web publications went together. There was some conflict between openness to the public and the internal discussions about criteria. Some claimed there should have been some separation in time so that the processes did not interfere with each other.

Civil servants claimed that the method contributed to neutralizing ideologies. Politicians, unsurprisingly, did not see neutralization but rather a more viable political debate. They felt that the ideologies stood out rather more strongly as they were manifested in the criteria and weights.

8. Conclusions

The Älgö case concerned three complicated and infected public decisions in a municipality outside of Stockholm. Having been stalled for many years, the decision process was restarted with the use of a PDSS, a transparent public decision support system. The PDSS had previously been used in public sector projects, but not in a project having such a high public profile, consisting of a set of very engaged citizen stakeholder groups with opposing views. The post-case investigation provided answers which formed a mixed picture:

- In general, there are mixed views about the usefulness of the method. Views are correlated with opinion on the planning issue at stake, but some issues can be discerned irrespective of that bias. In brief, the method provided better information, but no clear outcome.
- Everyone appreciated the increased openness and transparency that web publishing and ordering of information according to decision criteria have created.
- People often did not distinguish the method from the project. Nobody claims to understand fully just how the PDSS arrives at a solution.
- The full project took too long to be practical as a general method, but some believed that some components might be used regularly. The time spent was a function of the complexity and initial disagreement of the matter, and in less infected issues, the time spent is projected to be much less.
- Some people have put effort into understanding the method, and they appreciate it.
- Many claim the process was clearer than the standard procedure, both as concerns the matter in hand and the political debate.
- The citizens consistently claimed that the project did not make any difference to the factual matter. Also because they claimed that politicians had a hidden agenda they did not feel there has been more clarity this time.
- Even though formalization and good organization of information are generally acclaimed, there is also the view that precisely because of this formalization aspects which normally appear in the informal consultations among civil servants and citizens may be missed.

As the post evaluation shows, there are clearly many positive assessments of the method. Even though many of the problems the participants address can not be blamed on the method – e.g. the timespan – there is reason to consider their views. It might also be the case that the situation in this case was so infected after years of debate that no method would help to bridge the gulfs. Nevertheless, public decision making must not only be transparent, it must also be efficient. Even though clearly a first attempt requires a learning curve, there is reason to consider means of speeding up the process.

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