Decision Models in the Evaluation of a Cluster Programme

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1 Introduction

Technology programmes are the basic units of the public innovation policies in Finland. As the programmes concern nation-wide topics, and large amounts of funding is invested in them, their achievements have to be evaluated. However, a complete and impartial evaluation is difficult to perform. Thus, efforts to improve and rationalize the evaluation process have been, and will be, taken.

Within the Finnish forest cluster programme, the Wood Wisdom, we have approached the evaluation problem from a new direction. Traditionally, the ex post evaluation is carried out by an external expert, or at most by a group of authorities. In our approach, we have emphasized participatory evaluation, i.e. self-assessment in a series of workshops. Within the workshop environment, our aim has been to apply a decision support framework to promote the evaluation process. We are expecting the framework to make the process clearer and structure the evaluation into a transparent aggregate (e.g. Roessner, 1985; Edwards, 1977; Hämäläinen and Leikola, 1996). Applying numerical values to the evaluation statements would also be desirable, despite the challenges associated with subjective statements. In the workshops, computer supported participatory group collaboration itself should bring advantages to process (e.g. Gustafsson, 2000; Bongers et al., 2000). This paper focuses mainly on the usability of a decision support method, value tree analysis to be precise, for the purpose of programme evaluation.

In the paper, Sections 2 and 3 describe publicly supported RTD activities in Finland, introduce the Wood Wisdom cluster programme and consider RTD programme evaluation in general. Section 4 introduces the value tree analysis theory with previous cases and software implementation and discusses some shortcomings. Section 5 introduces and discusses the Wood Wisdom evaluation process and the value trees developed within the preparation phase. Section 6 summarizes the paper and draws conclusions for the suitability and the limitations of the approach.
2 RTD programmes in Finland

2.1 Research and development activities

Finland is a highly active nation in the field of research and development (R&D): in 2000, total R&D spending in Finland was FIM 25,9 billion, which is 3.3 per cent of the GDP, including both government-sponsored and private industrial R&D activities (http://www.tekes.fi, July 11, 2001). Public R&D support plays an important role in the Finnish innovation system. The public institutions involved in the funding and development of the Finnish R&D activities are shown in Figure 1. The science and technology policy council sets the overall direction for the RTD policy. The ministries and most of all the institutions in their govern are the implementing parties, i.e. allocate grants for RTD projects. The public sector’s portion of the total FIM 25,9 billion in 2001 was 7.5 billion, leading to a proportion of 29 per cent.

![Figure 1: Public institutions in the Finnish innovation system](http://www.tekes.fi)

(Tuomaala et al., 2001)

The National Technology Agency – Tekes – and the Academy of Finland are the two major public RTD programme financiers, with respective shares of 30 and 14 per cent of the total public funding. The two concentrate on different stages of RTD: In the programmes of the Academy of Finland, the focus is on basic research in all fields of science and humanities, while Tekes concentrates on applied technological research and
product development. The Academy of Finland primarily stresses generation of new knowledge, while the emphasis in the Tekes’ programmes is on the application of knowledge and generation of commercial outcomes (Tuomaala et al., 2001). Despite differences in their policies, these two agencies also have jointly funded programmes, especially in the context of large cluster programmes.

2.2 RTD programmes

Recently, the public research funding has increasingly been allocated to programme funding while the so-called untied funding has diminished. Altogether, approximately 16 per cent of the total funding was funneled through RTD programmes in 1998 (Tuomaala et al., 2001). The latest and the largest form of the national RTD programmes are the cluster programmes. Tuomaala’s description of a national cluster programme says:

“National cluster programmes are extensive research and development entities involving several sectors of Finnish society. In cluster programmes, national research, technology and industrial policy objectives are adjusted to needs of more limited regional frameworks, and they also provide an opportunity for cooperation between the administrative sectors responsible for raw material supply, infrastructure, service provision, legislation, etc. Public funding organizations, companies, the service sector, research organizations, ministries and other beneficiaries are some of the bodies which contribute to joint projects involving both the public and private sector.”

In the last three years there have been six major cluster programmes in Finland, some of them still going on. Except for the one on workplace development, each cluster programme has concentrated on the development of a specific industrial sector. They require cooperation between the public and private sectors and within the innovation system, and all involve joint funding. Due to their scope, cluster programmes often consist of diverse research projects, whose objectives may be very dissimilar. Thus, the types of research found in the cluster programmes extend all the way from basic research through applied research to product development.

2.3 Wood Wisdom

Wood Wisdom (http://www.woodwisdom.fi), launched in 1998, is the largest of the Finnish cluster programmes. The aim of the programme is to promote the competitiveness of the Finnish forest cluster in the changing operating environment (a
description of the Finnish forest cluster can be found in Seppälä, 2000, chap. 2). Wood Wisdom emphasizes a customer-orientated approach and thus aims at to promote the production and development of value-added, quality-competitive and eco-efficient products. The focal point of the research is market-driven, optimal use of Finnish wooden raw material. Integrating forestry and other parts of the production chain, as well as encouraging interdisciplinary networking and cooperation are also considered as significant goals for the programme. One branch of the programme also concentrates on forecasting and creating future scenarios of the forest industry. (Paavilainen, 2000)

Wood Wisdom is jointly financed by the National Technology Agency, Academy of Finland, Ministry of Agriculture and Forestry and Ministry of Trade and Industry, who each concentrate on somewhat different segments of the programme. In year 2000 the total funding was more than FIM 200 million, including both public and private sector funding. Approximately 400 scientists from nearly 70 major research facilities worked within the program (http://www.woodwisdom.fi, June 29, 2001).

Wood Wisdom consists of 140 on-going projects carried out by 70 companies and nearly 70 research facilities. Typically to the cluster programmes, the projects in the Wood Wisdom are very diverse. Thus, the projects are divided into four different research areas. Furthermore, each of these areas breaks down into theme areas, and these again into research consortia. Altogether there are 19 of these research areas, and 33 consortia. The management-organization of the whole programme consists of a full-time project coordinator and a 11-member managing committee. At the project-level there are 28 steering groups, mainly one for each research consortium. Steering groups consist mostly of industrial end-users of the respective research area, spokesmen of the financers and persons responsible for the projects within the consortium. The steering groups meet on the average two to three times a year, which allows an active exchange of knowledge, experiences and opinions (Paavilainen, 2000). More generally, the programme activities emphasize the exchange of information and cooperation; thus, the programme is more than a set separate projects.
3 RTD programme evaluation

3.1 Objectives

As RTD programmes are set to promote the national innovation system, and large amounts of funding are spent on them, the programmes and their achievements need to be evaluated. Internal evaluation, which is closely related to the programme management, is normally carried out throughout the programme. A major form of the internal evaluation are the steering group meetings mentioned above. But in addition, both Tekes and the Academy of Finland publish evaluation reports on all larger programmes. Roughly, in this external evaluation (Tuomaala et al., 2001), an external authority assesses the efficiency and the impacts of the programme, the achievement of objectives and the success of the individual projects. The evaluation may also concern the programme management and the strategic relevance of the research areas within the programme (e.g. Salo et al., 2000). With the cluster programmes, the development of cooperation and networking, as well as the expected progress of the cluster, are dimensions to be evaluated as well. The final report describes the facts of the programme, added with an evaluation of the impacts of the unquantifiable outcomes. In addition to serving as a summary of the programme, the information may often be used as a some kind of preview of the expected future, or in the case of consecutive programmes, for planning and preparation of the subsequent programme (Gustafsson, 2000).

The objectives of the Wood Wisdom evaluation mainly follow the general ones described above. As the cluster programme is large and diverse, the success of the individual projects gains less attention, whereas the focus is on assessing the impacts of the achievements of the project consortia on the competitiveness of the forest cluster as a whole. The Wood Wisdom is about to launch a sequel, so practical affairs, i.e. programme activities and management, are also considered. Views on the relative importance of the dimensions of the programme are important information for planning the future. However, the main task is not to forecast the future, but the views are rather collected in the course the evaluation process.
The evaluation methodology is yet fairly immature. Berg and Lindberg (1997) have created a practical tool for Tekes’ RTD programme evaluation, but as they introduce the method, they recognize that the evaluation criteria and implementation are flexible and highly project-specific. Furthermore, the focus on the Berg and Lindberg’s report is not on the external ex post evaluation, but more on the internal evaluation and programme management. Although one key aspect of the evaluation is to look into the future, neither technology foresight (e.g. Gustafsson, 2000) completely covers the field of cluster programme evaluation. Both the foresight and the widely reported project selection methods (e.g. Henriksen and Traynor, 1999) concentrate on ranking a set of alternatives and thus giving recommendations for the decision makers. Salo et al. (2000) offer one real-life example of programme evaluation, but again the method is not applicable for our case as such. To sum up, cluster programme evaluation cannot - and on the other hand, must not - be derived from any existing framework. While objectives are given, some steps from the previous evaluations may be repeated, but otherwise the evaluation process developers are given a fairly free hand.

3.2 Motivation for a decision support method

Tuomaala et al. (2001) write that the programme evaluation should be carried out by an external evaluator, who is an authority in field of the technology programme. For aggregating an objective and impartial view, the number of these authorities acting as external evaluators should be large. The latter is required especially in case of the cluster programmes, since they include different kinds of research activities with different kinds of objectives. Furthermore, within the forest cluster the outcomes often cannot be quantified in numbers, and some of the foreseeable gains may implement only in the future. Thus, the best possible evaluators would most probably be the experts of the forest cluster and the end users of the outcomes. In Wood Wisdom, the consortia steering groups already largely consist of such actors. Therefore, the boundary between the internal and external evaluation will become blurred, bringing these two closer to each other.

As the number of evaluators increases, there is a risk of producing a miscellaneous load of information. A decision support framework makes it easier to structure the evaluation
statements into an aggregate, to reveal the origins of possibly conflicting viewpoints and to direct the conversation towards relevant topics. Furthermore, with help of a decision support model, it is easier to express the conclusions and the statements of the workshops, as at least part of the data is captured by the model, i.e. converted from open comments into numerical values.

An efficiently facilitated use of a decision support method also promotes fairness in workshop working. When using the model, i.e., most often voting or giving statements and analyzing the results with a computer, all viewpoints can be taken into consideration. In an informal discussion, the loudest speaker may take over the stage. A decision support method does not give direct answers to difficult questions, but it does collect the opinions equally and processes them into a more illustrative form. After all, an effective use of the methods allows – even requires – discussion, adjustments and iterations. As the evaluation consists of several workshops, a shared method directs all of the workshops to evaluate the programme in a similar manner, i.e., to consider and give statements on the same aspects, within similar scales, information and circumstances. An appropriate decision support method may then promote the fairness and consistency of the evaluation process.

An important factor when contemplating the use of such models is time. In order to function properly, i.e., to generate reliable and acceptable outcomes, the use of the methods requires enough time. This is twofold: on one hand there are the benefits attained, but on the other hand, the time used with the methods is detracts the time for free discussion. But as mentioned above, a decision framework, even as a part of the workshop agenda, helps to keep the contents of the workshops substantially commensurable with each other.

In the literature, I have not found any reports concerning the use of decision support methods within a programme evaluation. The models are mainly used for more straightforward problems, whose purpose is often choosing between alternatives. Hartwich and Janssen (2000) demonstrate a hypothetical AHP-based example in ex post research evaluation. However, the process had not been put into practise, and many of the
conceivable defects of the approach have simply been walked over by favourable assumptions. Thus, the paper may not be taken as an actual experience-based precedent on the issue. Yet, it does explore the possibilities of using a multiple criteria decision support method within a research programme evaluation. Furthermore, there are papers reporting so called political decision making cases, that are somewhat similar to the one considered in this case. The conclusions are mainly promising, and the user satisfaction in the methods tends to be high. Within political decision making cases, two points seem to come up. First, for example Roessner (1985), Bana e Costa et. al. (1999) and Hämäläinen and Leikola (1996) all stress gains other than generating the actual decision. These are for example creating a better understanding of the whole problem, identifying the most important factors of the outcome or systematically presenting the views of the different stakeholders. Hämäläinen and Pöyhönen (1996) utilized a specific model for directing the discussion and for seeking consensus. Second, e.g. Edwards (1977) expresses that for attaining approval for the actual results of the models, they should be ‘transparent’ and clear. It is important that the decision makers understand the basic theory of the model and agree on using it. Thus, an inviting method would be the often-used value tree analysis.
4 Hierarchical weighting methods

4.1 Value tree analysis in general

As the decision problems get larger and more complex, the demand for a decision support model increases. No matter what the complexity of the decision, the fundamental requirements for an acceptable model are practical rather than scientific or mathematical, i.e. the model has to be most of all understandable and usable. In her dissertation Mari Pöyhönen (1998) has aptly written: “Value tree analysis is not necessarily the winner among the decision support methods but it is at the moment used in practice... One advantage of value tree methodology is indeed that it is basically a simple method for decision makers to understand and for everybody to use.” Based on its fairly simple theory and some encouraging result of previous cases, the value tree analysis seems inviting to be the decision support method applied to the context of programme evaluation.

In his later works (Saaty, 1990; 1994) the developer of the Analytic Hierarchy Process, Thomas Saaty, widely presents cognitive and behavioral grounds for the hierarchical decision and brainworking concept. Saaty introduces the AHP (see Section 4.3.2) as a separate method, but the aspects and arguments concerning the rationalization of the decision framework apply to all hierarchical weighting models. The value tree model helps the decision maker to solve a complicated decision problem part by part. The hierarchical structure of the tree also helps to study the build-up of the outcome and thus gain better understanding of the whole system. The simple and linear structure of the model probably makes the outcomes more acceptable and, in case of group decision making, more easily negotiable.

A value tree consists of hierarchical levels of criteria in a tree-like form. On top of the tree there is the most general of the so called fundamental objectives (Clemen, 1996; see also Section 4.2). Saaty (1990; 1994) uses the term focus for the main, or ultimate, objective. On the root of the tree there are the alternatives. For an example of a value tree, see Figure 2. The criteria may break down into number of subcriteria, which may again break down etc. Theoretically, the size of a value tree is not restricted in either direction,
i.e., there might be a large number of criteria within a specific level of hierarchy and the
number of levels could be large. For practical reasons, the trees used in application are, or
should be, relatively small (see Sections 4.2 and 4.3). The trees do not have to be as
symmetric as the one illustrated in Figure 2, i.e. all of the criteria do not have to break
down alike.

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Figure 2: An example of a two-level value tree with three alternatives

All the alternatives must have a rating on each of the lowest level criteria. A numerical
scale, an attribute, is attached to each criterion. For example, if one is deciding between
jobs and one of the criteria is salary, the respective attribute would most probably be
monetary units per month. In value tree analysis these ratings are converted into values,
most often between zero and one. The conversion formula is called the value function.
The form a value function may vary from case to case; it may be linear or nonlinear and
so on, but the basic principle remains the same. The idea of a value function is that the
best alternative against the respective criterion gets value of one, and the worst gets value
of zero, and finally the others something in the between. Once the relative importance of
the criteria, the weights, are elicited (see Section 4.3), the calculation of the outcome is
straightforward. According to the ratings and weights, all the alternatives get a value on
each branch of the tree. In the additive model, these partial values are summed up to
aggregate the overall value. In the multiplicative model, the partial values are multiplied.
with each other. For example Henriksen and Traynor (1999) discuss the properties of the additive and multiplicative model in more detail. Because of the normalization of the weights and the value functions, each of the alternatives finally get a overall value from zero to one, and thus the bigger the overall value, the ‘better’ the alternative. Once the overall values are established, a sensitivity analysis is usually carried out. The term sensitivity analysis refers to examining the changes in weights or ratings needed to reverse the just established preference order of the alternatives. If the order is highly sensitive, i.e. a slight change may reverse it, a decision maker should be allowed to reconsider his or her statements to gain better support for the outcome.

To summarize, at its simplest the value tree analysis is nothing but a weighted average of the performance of the alternatives. The concept is not too intricate, and with proper instruction it should be understandable and usable also for decision makers who are not familiar with it beforehand. In practice, value tree analysis has been used for example as one phase of a large, multiple stage political decision making case, the Lake Päijänne case (http://www.paijanne.hut.fi).

4.2 Structuring the value tree

Roughly, value tree analysis consists of four phases: structuring the problem, analyzing the alternatives, the weighting, and finally analyzing the results and their sensitivity. The largest and probably the most important of the phases is the structuring. The structuring includes the identification of the stakeholders, the alternatives, and most of all identifying the criteria and their relations as a value tree. The structuring phase is not easy. It requires creativity and strong expertise both in the field of the decision problem and in decision analysis. Another thing is, that there is no particular method or formula for the creation process, but the process may be performed rather freely. A few fundamental rules and restrictions must though be taken into consideration.

A value tree should be both minimal and complete, i.e. it should include all the essential properties of the problem (of the alternatives), but also be as small as possible. The completeness is required because all of the decision makers’ judgements and preference statements should be given within the value tree. An imperfect tree may prevent a DM
from expressing his or her true preferences, and thus makes the tree prone to biases and inconsistent statements. Reasons for keeping the tree small are mostly practical. First of all, processing a smaller tree takes less time. Second, in case of larger groups, Pöyhönen and Hämiäläinen (2001) have shown that the increased number of criteria being compared simultaneously increases the spread and inconsistency of the weights elicited.

It is essential that the criteria are set to draw distinctions between the alternatives. The criteria should also differ from each other, because if there are two or more criteria that actually represent the same property, the relative importance of the respective property may increase unintentionally. Considering the comparison of the relative importance of the criteria, they should be tradable, i.e. one should be able to say that “this criterion is more important than that other one, and these two are equally important etc.”. With the additive model, the criteria should also be preferentially independent, i.e. the preference order of the alternatives against a specific criterion must not be affected by the other criteria. In practice, the checking of preferential independence often gets only minor attention. But with the additive model, it is important to exclude vital criteria, whose zero-performance makes an alternative completely useless. If there are such ‘boundary condition’ criteria, an alternative, which simply does not fulfill the minimum requirements on that criterion, may still get the greatest overall value. Of course, this should not be possible. With the multiplicative model this is not an issue: the values of the branches being multiplied with each other, if an alternative gets a value of zero on one of the branches, the overall value of the alternative is also zero.

Clemen (1996) has introduced the following graph, figure 3, to help creating the hierarchy. An important task is to separate the fundamental objectives from the means objectives. Clemen writes: “This is a critical step, because we indicate those objectives that are important because they help achieve other objectives (means) and those that are important simply because they reflect what we really want to accomplish (fundamental)”. In this approach, only the fundamental objectives are organized into hierarchies, whereas the means create a different kind of network. As mentioned above, in practice the value trees are often structured rather freely, but for example the fundamental – means separation is an effective way of preventing the overlap of the criteria. Saaty (1990; 1994)
gives a great deal of advice on the structuring and further categorizes the techniques, methods and hierarchies. Hammond et al. (1999, chapters 1-5) offer a practical, reader-friendly overview on the decision problem definition with plenty of descriptive examples. French et. al. (1998) present a workshop constructed to examine three approaches to formulating a ‘decision mess’ into a soluble problem. The approaches are described precisely with comments, and thus practical advice for structuring the problem is given.

<table>
<thead>
<tr>
<th></th>
<th>Fundamental objectives</th>
<th>Means objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>To Move:</td>
<td><strong>Downward in the Hierarchy:</strong></td>
<td></td>
</tr>
<tr>
<td>Ask:</td>
<td>&quot;What do you mean by that?&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Away from Fundamental Objs:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;How could I achieve this?&quot;</td>
<td></td>
</tr>
<tr>
<td>To Move:</td>
<td><strong>Upward in the Hierarchy:</strong></td>
<td></td>
</tr>
<tr>
<td>Ask:</td>
<td>&quot;Of what more general objective is this an aspect?&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Toward Fundamental Objs:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;Why is this important?&quot;</td>
<td></td>
</tr>
</tbody>
</table>

(WITI)

Figure 3: “How to construct mean-objectives networks and fundamental-objectives hierarchies” (Clemen, 1996)

The structuring phase is critical to the success of further analysis. But often, the structuring itself may be the most productive part of the whole value tree analysis process. Thinking thoroughly about the aspects that influence the outcome gives the participants a better understanding of the problem as a whole, and thus supports their decision making indirectly (see, Hämäläinen and Leikola, 1996). In the literature, the phenomenon is called the learning process. The term learning process also refers to the point that the value tree analysis may make it easier to expose the reasons behind possibly conflicting viewpoints. So the structuring phase creates as a basis for value tree analysis, but also serves as decision support itself.

4.3 Weighting

Once the tree is constructed and the alternatives’ ratings are given applicable values, the next step is the weighting of the value tree. Most often, the process is called attribute weighting, so from this point on the term attribute is used instead of the term criterion. To
find out, which of the alternatives (which probably have different strengths) is the best one, or which of the attributes most contributes to the outcome, the importance of the attributes must be determined. The term ‘importance’ cannot be defined unless is has a point of comparison. Thus, the value tree weighting techniques concentrate on untangling the preference ratios between the attributes. The information required is gathered and then converted into weights through a specific method. Most often, the weights are normalized, i.e. the figures are calculated to sum up to a value of one. Then, the weight simply indicates the importance of the attribute as a ratio of one.

Theoretically, weight of an attribute reflects the relative importance of the change in rate of the respective attribute from its worst plausible to its best plausible level. The expressions ‘relative importance’ and ‘plausible level’, play an important role in the multiattribute value theory. All the judgements should be given by simultaneously considering the context set by the alternatives, i.e., the scales in which the attribute ratings vary with the alternatives available. Unfortunately, for example Pöyhönen et al. (2001) have shown the existence of the so called range effect, i.e., the decision makers do not adjust their statements to the prevailing scale of the respective attribute, but rather rely on their expertise in making the preference statements.

However, the weights are basically elicited either by weighting each of lowest level attributes at once (non-hierarchical weighting) or by setting weights to attributes within one level at a time and then multiplying the local weights through the respective branches of the value tree in order to achieve the final weights (hierarchical weighting). Figure 4 illustrates an example of both ways. If setting the lowest level weights and thus choosing between a number of alternatives is the only purpose of the value tree process, hierarchical weighting obviously requires a set of weights that are not directly used. Yet, it has two advantages: First, in real life applications the total number of the lowest level attributes presented to describe the alternatives may get large. Second, the hierarchical weighting automatically provides a chance to analyze the build-up of the final weights as it generates the weights of the upper level objectives more naturally and smoothly than the non-hierarchical procedure. In some cases analyzing the weighted value tree as such may be the only desired outcome (see, e.g. Bana e Costa et al., 1999). Third, the splitting
bias phenomenon can be avoided or at least reduced with hierarchical weighting (Pöyhönen and Hämäläinen, 1998; Pöyhönen et al., 2001).

Figure 4: Weighting techniques in general (Pöyhönen and Hämäläinen, 2000)

The following Sections describe three basic types of weight elicitation methods. The aim of the methods is to help the decision-maker to convert his or her judgements into feasible value tree weights. A straightforward way is direct weighting, i.e., setting simple numerical values to describe the relative importance of the attributes; take percentage shares for example. In practice, direct weighting is often not that easy, and some the following may come in handy. The methods represented are the most widely known, ‘official’ methods, but basically any procedure, that gathers the decision makers’ preference information and fairly converts it into feasible weights, is acceptable. The following methods have been criticized for yielding different weights for the same problem. However, Pöyhönen and Hämäläinen (2001) have shown that the differences originate from the decision makers’ behavioral inclinations, not from the methods themselves. In their study Pöyhönen and Hämäläinen also concluded that the differences between the weights are not too severe, and that no method can claim to be better than another one.

4.3.1 Ranking-based methods

In ranking-based methods the order of priority of the attributes is determined by the decision maker. There are two types of ranking-based methods: ordinal and cardinal. *Ordinal methods* merely consider the rank order, and then convert the rankings into
normalized weights. The most often appeared of the ordinal methods is the SMARTER technique (Edwards and Barron, 1994). The *cardinal methods* consider the magnitudes of the preferences as well. In the SWING weighting (von Winterfeldt and Edwards, 1986), the decision-maker first chooses the most important of the attributes and attaches 100 points to it. Then the DM evaluates the other attributes compared to the most important one, by adding points (at most 100) to them. When all of the attributes are considered, the formula calculates the weights, based on the points given. Thus, the cardinal methods accept equal importance, whereas the ordinal methods require a complete ranking order. Along with the SWING, the SMART procedure (Edwards, 1977; Edwards and Barron, 1994) is another commonly referred cardinal method.

Perhaps the greatest advantage of these methods is that they are quick and theoretically straightforward. However, the weights based on the rank order only can lead to biases when the structure of a value tree is changed (Pöyhönen and Hämäläinen, 1998). In case of a pre-structured value tree, presuming that the structure is not allowed to change, splitting bias cannot occur. A shortcoming of the SMARTER technique is its lack of accepting equal importance. Problems concerning the SMART and SWING procedures include the splitting bias and the unadjustment phenomenon (Pöyhönen et al., 2001). A pre-set, balanced value tree can decline the effect of the shortcomings. So, at least in case of pre-set, small and harmonious value trees, the ranking methods offer a quick and easy-to-understand option.

### 4.3.2 Analytic Hierarchy Process, AHP

The Analytic Hierarchy Process (Saaty 1990; 1994) differs from the methods above by asking pairwise preference statements instead of considering various attributes simultaneously. The AHP is a cardinal method (see Section 4.3.1). Theoretically, the AHP is very inviting. The decision maker is asked to assess the importance of the attributes in pairs, one against another. As all of the pairwise comparisons are complete, i.e. \( n(n-1)/2 \) statements in case of \( n \) attributes, the weights of the attributes are produced with simple matrix calculations. Hence the AHP works other way around compared to the other methods: it produces the priority order subliminally through pairwise comparisons. For most people, it is probably easier to compare the attributes one-on-one, and thus the
AHP has become popular. Again, quoting Mari Pöyhönen on her dissertation (Pöyhönen, 1998): “Especially the Analytic Hierarchy Process, which is in practice used in the same way that the other value tree methods, has made its way to many practical applications.”

Although the AHP is sometimes presented as a separate method, it can simply be used as a weighting method in a value tree. It may also be combined with one or more of the methods introduced above. Mustajoki and Hämäläinen (2000) discuss and introduce the mathematical details of combining MAVT-based weighting and AHP in one decision hierarchy. Salo and Hämäläinen (1997) discuss the AHP from a perspective of multiattribute value measurement and deal with imperfections of the method.

One of the main problems with the AHP is that it is fairly time-consuming. The amount of comparisons is large and if the preference statements turn out to be widely inconsistent, the DM should be given a possibility of adjusting them. Use of the AHP would also require decent instructioning and user support. Another shortcoming is in connection with comparison scale used (see, Pöyhönen and Hämäläinen, 1997; 2001; Salo and Hämäläinen, 1997).

4.3.3 Methods for partial preference information

Recently, the emphasis has been on methods treating incomplete or partial preference information, such as preference programming (Salo and Hämäläinen, 1995), PAIRS-method (Salo and Hämäläinen, 1992) and PRIME (Salo and Hämäläinen, 2001; Gustafsson et al., 2001). All of these extend the above methods by allowing the decision-maker to set intervals for the weight ratios and comparison scales instead of exact number estimates or strict rankings. The intervals can be interpreted to denote the decision-maker’s preferential uncertainty. Accepting this kind of uncertainty makes the methods for partial preference information more flexible and, one could say, more lifelike, which probably makes the results and recommendations attained with the model more admissible. For actual selection cases, like project selection in which the purpose is to find a dominant alternative to implement, the partial information methods would probably be the most suitable. The methods also fit well for seeking consensus in group decision making (Hämäläinen and Pöyhönen, 1996). The partial information methods
are certainly workable, but again time-consuming, theoretically more complicated and possibly too focused on the reach for the dominant alternative.

4.4 Group Decision Support Systems

Group Support Systems, GSS:s are computer facilities designed to support group collaboration. The term GSS refers to a wide range of equipment, which somehow advance group settings, including for example electronic meeting tools and anonymous commentary possibilities. Gustafsson (2000) and Bongers et. al. (1999) discuss the overall gains of group support systems and their contribution to group settings as a whole. Group Decision Support Systems, GDSS:s, are software to support complex multiple criteria decision making especially. Many of the systems offer a software implementation of the value tree analysis. The extensive use of these software is spreading and several studies concerning GDSS have found the systems attractive and advantageous (e.g. Hämäläinen, 1996; Bana e Costa et al., 1999). The variety of these systems is quite comprehensive (see, for example http://www.decisionarium.hut.fi), and a simple value tree study can be conducted with the widely used MS Excel as well (see, for example Bots et al., 2000; Henriksen and Traynor, 1999). The differences between the actual decision support software appear on the solution methods and problem structuring tools provided. Common to all GDSS:s is an easy-to-use graphical user interface and usually a graphical, illustrative representation of the results. A collection of GDSS:s developed at the Systems Analysis Laboratory of Helsinki University of Technology (www.sal.hut.fi) is presented in article by Hämäläinen (2001). Two of these are discussed briefly as follows.

4.4.1 Web-HIPRE

Web-HIPRE (Mustajoki and Hämäläinen, 2000; http://www.hipre.hut.fi; Hämäläinen, 2001) is a web tool for supporting different phases of value tree analysis. With the graphical user interface, all the phases are carried out visually. The weighting methods include direct weighting, SMART, SMARTER, SWING and AHP. Value functions may be linear, piecewise linear or nonlinear. The value functions may be shaped either visually with the mouse or by setting exact figures. Several decision makers’ judgements may be aggregated, as a weighted average if needed, to find out the group’s view of the
overall values. Unfortunately, the group feature only allows to study the aggregate view of the overall values of the alternatives, not at all the collective statements of the weights. The results are presented by illustrative bar charts and a comprehensive graphical sensitivity analysis is also available. Both the results and their sensitivity may be examined in different segments in order to study the build-up of the outcome. There is also a possibility of attaching www-links to the elements of the value tree, and thus offering the decision maker an immediate access to further information on the subject.

Considering the use of Web-HIPRE with group decision making in a work-shop environment, the graphical features of the software show their worth. The graphics are very clear and illustrative. Web-HIPRE is also a straightforward software: there are not too many controls, everything is carried out visually with mouse control and the results are easy to understand, even with only few experience on the value tree analysis. The weighting windows also update the weights immediately and display them as bars. The decision maker can easily notice the effect of the changes made, and the final weights are clear to interpret at a glance. For a more detailed analysis, exact figures are however shown on all the phases. The overall graphical layout of the Web-HIPRE also supports the work-shop work. All the elements are large and not too detailed, so the software may easily be displayed on a wide-screen without losing visibility. Web-HIPRE was also the tool used in the value-tree phase of the Lake Päijänne case (http://www.paijanne.hut.fi, 6.8.2001).

4.4.2 Opinions Online

Opinions Online (http://www.opinions.hut.fi; Hämäläinen, 2001) is an internet platform for group collaboration by voting and surveys. The questionnaires and the results are located in the world wide web. Opinions Online offers a wide selection of methods for gathering information: the voting methods include approval voting, ranking of the alternatives and multiattribute rating of the alternatives. Basic multiple-choice and open-ended questions are available as well. The use of Opinions Online is also fairly easy: the questions are mostly answered by mouse-control, excluding the open-ended questions and the ratings. The graphical layout of the questionnaire sites is quite elementary, but yet functional.
Just like in Web-HIPRE, the presentation of the results in Opinions Online is extremely clear and illustrative. Opinions Online is also very quick, i.e. the results are updated immediately as new responses are sent. The results may be studied besides the aggregate by sampling the respondents into groups according to their responses on different questions. For example, if there is a question on the respondent’s age, the responses of respondents over 30 years old may be examined separately. As a voting tool, Opinions Online is suitable for group decision making. The graphical features and ease of use also support the software’s applicability for work-shop working.

However, there are some shortcomings in the Opinions Online. First, there may be no more than one or two open-ended questions per questionnaire, which limits the use of Opinions Online as an anonymous commenting facility. Second, the verification of the statements given is in some respects inadequate: In the rating format, if the evaluators are asked to share 100 per cent among the criteria, and someone accidentally types 1000 on one of the blanks, the software accepts the violating figure and thus corrupts the averages. In the ranking format, it is possible to rank a single alternative on each ranking which skews the results. The latter is unlikely to occur except through deliberate misuse, but the former may take place in practice. With the multiple choice questions or with the approval voting such user-based flaws should not occur.
5 Evaluation of the Wood Wisdom

5.1 The evaluation process in general

The contemplation on whether the value tree analysis is suitable for supporting a cluster programme evaluation came up when designing the evaluation process of the Wood Wisdom programme. Also in general, the evaluation has been approached from new direction, emphasizing self-assessment, participatory discussion and collecting a wide sample of views. Partly, this approach is not fully compatible with the idea of external evaluation (Tuomaala et al., 2001), collecting assessment statements inside the programme. However, the Wood Wisdom seems too diverse to be objectively and exactly evaluated by a single external person. In addition, the members of the steering groups are clearly qualified to act as evaluators: they are mostly senior representatives from wide range of organisations and should not have a motive to either exaggerate or underestimate the performance of the programme. And yet, the responsibility for interpreting and utilizing the internal statements is still left to external parties. Thus, the structure of the Wood Wisdom offers a possibility for an objective, participatory evaluation. Additionally, the evaluators being present in the workshops, a decision support method may be set to support the process. At the time of writing, the final evaluation process and the methods to be used are still under construction, but plenty of discussion has already taken place and the major guidelines are clear and pretty accurate.

The general objectives of programme evaluation are discussed in Section 3.1. The objectives of the Wood Wisdom evaluation are roughly summarized in Table 1. The evaluation is clearly two-dimensional: First, there is the object of the discussion – after all, the programme should be more than its projects alone. Second, the period of time being evaluated must be determined when giving assessment statement. The time distinction is clear on the programme level. But on the project level evaluation, the distinction is not that clear or useful. However, the future aspect must be included when evaluating the projects, since the changes and impacts take place rather slowly in the forest cluster. Thus, a project that has not achieved anything concrete by now, may still be perfectly successful and effective as a whole.
**Table 1: The objective dimensions in the Wood Wisdom evaluation**

<table>
<thead>
<tr>
<th>Past, <em>ex post</em></th>
<th>Programme</th>
<th>Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The effectiveness and achievements of the closed programme:</td>
<td>The already gained achievements of the projects in the programme:</td>
</tr>
<tr>
<td></td>
<td>• Networking promotion</td>
<td>• Tangible results</td>
</tr>
<tr>
<td></td>
<td>• Flow of information</td>
<td>• Intangible results</td>
</tr>
<tr>
<td></td>
<td>• Contentual guidance for the projects</td>
<td>• Bootlenecks and difficulties</td>
</tr>
<tr>
<td></td>
<td>• Management</td>
<td>• The effects and relevance of the results</td>
</tr>
<tr>
<td></td>
<td>• Practical arrangements</td>
<td>• Networking development</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Future, <em>ex ante</em></th>
<th>Preparation of the ensuing programme:</th>
<th>The gains yet to implement and the effectiveness of the project</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Gradients on the previous =&gt; proposals for improvement</td>
<td>• Tangible</td>
</tr>
<tr>
<td></td>
<td>• Establish the focal research areas in the near future =&gt; the guidelines for the project portfolio of the ensuing programme.</td>
<td>• Intangible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Foreseeable difficulties</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The overall effectiveness of the project</td>
</tr>
</tbody>
</table>

As a whole, the evaluation process consists of a preliminary questionnaire sent to the workshop participants, 15 workshops, and finally, based on the information and views gathered in the previous, the writing of the final report. The questionnaire acts as a preliminary view scanner, and its relevant results will be presented in the beginning of each workshop to create a basis for the conversation and to even up the level of information of the participants. On the other hand, the results of the questionnaire are used as such when writing the final report. In addition to the previous, the workshop agenda includes project presentations of the participating projects, application of the evaluation framework to the programme and the projects, and finally free discussion enriched with the results of the analyses. The workshops last four hours each, and the time reserved for the use of the evaluation frameworks is an hour and a half, two hours tops.

The programme coordinator chooses the representative and suitable consortia and projects to be the evaluators. In the preliminary phase, the questionnaire has been sent out to 78 of the 130 projects, representing 23 consortia of the total 33. The sample covers all areas of the programme. The projects have mostly been chosen based on their closing date: the recently finished projects are preferred. The workshops each include participants among one or two consortia. The 10-15 participants of each workshop consist of
members of the consortium steering group and persons responsible for the participating projects. The workshops are facilitated in a conference room in the System Analysis Laboratory. Computer support is provided: the participants shall have a lap-top to use, and the facilitator is capable of presenting data through a projector. The discussions in the workshops are also recorded.

5.2 Use of the value tree analysis as the evaluation framework

Even though the basic theory of the value tree analysis is fairly simple, the structuring of the tree may get difficult in practice. The requirements for a functional value tree, listed in Section 4.2, are actually pretty exacting. Often, the relevant topics concerning the problem simply do not ‘fit’ into a value tree, i.e. it is not possible to create a functional and comprehensive tree around them. After all, the support models must be created on terms of the evaluation objectives, i.e. important topics cannot be left out of consideration on the grounds of not being applicable in the model. Because of the time restrictions, we cannot add new topics, aroused in the workshop discussion, into the trees; the idea of altering the tree would also fight against the idea of promoting fairness between the workshops. As we do not have a possibility to run through the structuring phase of the analysis with the participating evaluators, the topics accepted into the tree must be transparent and general by nature. Then, the question is whether too general information is even worth eliciting. Although discussion is significantly involved in the implementation phase of the analysis, the time spent with the value trees is away from conventional discussion. Thus, the value tree analysis should be able to produce some additional value to the process.

Several meetings and discussions have taken place due to the preparation of the evaluation. In these, the most important player has been professor Ahti Salo, who is an expert in the field of decision analysis and technology foresight. The Wood Wisdom programme coordinator and a senior technology expert of Tekes have also contributed to the preparation. However, the information flow has been somewhat deficient. The details of the programme and the exact required objectives of the evaluation have not been completely clear during the preparation. The insufficient ground information has in some degree made it difficult for us to branch down the problem into an exact value tree.
A more general challenge has been to choose the units of analysis. The programme level evaluation should of course concern the whole programme. However, the Wood Wisdom has been a very diverse programme. Furthermore, the evaluators are invited to the workshops roughly consortium by consortium. Thus, to gather reliable statements, the consortia steering groups are asked to assess the issues only in context of their consortium. This lead to a fact that the results gathered in the workshops are not fairly comparable with each other. And because attaching programme-wide scales to the evaluation criteria is not reasonable, the idea of aggregating the overall performance of the programme as a ‘sum’ of the consortia is not reasonable.

The above is an issue of programme evaluation in general. But the line-up of the workshops also affects the use of value tree analysis: as the participants roughly represent the same field of the cluster, the amount of conflicting objectives is likely to diminish. Thus, the ability of the analysis to deal with such trade-offs cannot be exploited to its full extent. Despite these constraints, we have thoroughly considered the use of value tree analysis in the Wood Wisdom evaluation. The following subSections discuss the analysis as structure with respect to fields of Table 1. The practical features related to the actual implementation of the analysis are considered in Section 5.3.

5.2.1 Ex post evaluation

The aim of the value tree analysis is to support multiple criteria decision making. Although the RTD evaluation is not exactly decision making (in terms of choosing), the basic framework is the same: the overall performance of the objects consists of multiple factors, some of which possibly conflicting with each other. With the Wood Wisdom, the structural requirements, i.e. balance and compactness, and time limitations first seemed to be the major challenges. However, once we have specified and branched down the evaluation criteria, it has turned out that these are often not meaningfully tradable and commensurably additive. The programme deliberately consists of a portfolio of projects, and thus the projects and their objectives have been very different from each other. In value tree analysis, the set of alternatives should be somewhat homogenous, then differing from each other against different criteria, all of which should be relevant to each alternative.
At the programme-level, using the value tree analysis to evaluate the quality of the programme management seems pointless, and was not even contemplated. Of course, the evaluators could weight the importance of the management instruments and then give a grade against each. However, such questions were established with the questionnaire, but not in a format of a value tree. Concerning the management topics, rather anonymous commenting facilities and improvement voting would promote the process. Networking development may again be branched down into research, industrial and international networking for example, but in the ex post –sense weighting these would be somewhat artificial. Again, the topics are important, but they gain no extra from being considered as a value tree.

On the project-level, the hierarchy illustrated in Table 2 was considered. The topics are fairly general and seem inviting to aggregate the overall success of a project.

Table 2: Considered ex post project-level hierarchy

<table>
<thead>
<tr>
<th>The ‘success’ of a project</th>
<th>RTD gains</th>
<th>S&amp;T research</th>
<th>Economic</th>
<th>Societal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced networking</td>
<td>Research collaboration (domestic)</td>
<td>Deepening</td>
<td>Broadening</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Industrial collaboration (domestic)</td>
<td>Deepening</td>
<td>Broadening</td>
<td></td>
</tr>
<tr>
<td></td>
<td>International collaboration</td>
<td>Extention</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

But when evaluating the past performance of a project, the weighting becomes problematic. In the value tree analysis, the weighting should express the decision makers’ preferences or views over resource allocation. In this case, weights attached to the framework of Table 2 would most probably reflect the orientation of the respective project. Neither is it fair to demand a desired resource allocation between the topics, and then ask ratings to the projects against the lowest level criteria: Although the steering group members would on a general level emphasize applied research and networking
development, they might still find a completely basic research oriented project fully effective. Expressing the above with a value tree analysis built around the framework of **Table 2** would be extremely difficult, or even impossible. Yet, a basic requirement in the value tree analysis is that the tree and the weights remain the same for the whole set of alternatives. Thus, the basic approach of the analysis, with DM’s preferences of the criteria and the alternatives’ performance against the criteria, is not suitable in this context. The framework may of course help the evaluators to assess the projects, but the weighting of the tree is not reasonable in project-level ex post evaluation.

In ex-post evaluation, the additivity may also be inconvenient. In order to promote the evaluation of effectiveness, the topics of the rightmost column of **Table 2** could each be further branched down into a triplet of quality/quantity/relevance. These are clearly criteria that cannot be either weighted or added together, because a zero-performance of any one of them should bring the overall effectiveness down to zero. Furthermore, summing up the scores of RTD gains and enhanced networking is not necessarily reasonable, as they are by nature quite different from each other. Although the difficulties discussed in this paragraph contribute to the use of value tree analysis, I have to point out that they are related to the programme evaluation itself, and do not derive from the value tree analysis.

Another difficulty is the rating of the performance statements. In a complete value tree analysis, the alternatives should have a commensurable numerical rating against the lowest level criteria. However, the interpretation of numbers varies from person to person: for example Pöyhönen (1998) found that with such verbal-numerical scales, people mainly choose between the verbal statements, neglecting numerical values attached to them. Furthermore, the determination of scales, i.e. basically the maximum and minimum performance of the projects, is controversial. This means that the phrasing of questions and the scales may have a significant influence on the analysis. Thus, a complete value tree analysis in an ex post evaluation may become both uncomfortable (the weighting and the aggregation) and highly sensitive (the ratings). The problems are general by nature in the evaluation, but with our boundary conditions the value tree analysis rather amplifies than solves them.
5.2.2 Ex ante evaluation

Whereas the value tree analysis is restricted for ex post evaluation, for the purposes of ex ante evaluation the approach would seem more applicable. First of all, when planning the future with such hierarchy, the ratings describing the performance of the alternatives are not required. Thus, the inconvenient aggregations may be left out of consideration. In the ex ante sense, the process is to elicit the weights to illustrate the resource allocation between the criteria. Then, the difficulties relate to the selection of a complete set of fairly tradable criteria. In this approach, the basic terms of the value tree analysis should actually change places: the topics in the value tree, that normally are criteria for the alternatives, have now themselves become the alternatives.

Table 3: The programme level ex ante hierarchy

<table>
<thead>
<tr>
<th>The future RTD orientations in the cluster</th>
<th>RTD efforts</th>
<th>S&amp;T research</th>
<th>Other research areas</th>
<th>Research collaboration (domestic)</th>
<th>Industrial collaboration (domestic)</th>
<th>International collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced networking</td>
<td></td>
<td>Basic research</td>
<td>Economic</td>
<td>Deepening</td>
<td>Broadening</td>
<td>Extention</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Applied research</td>
<td>Societal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Product development</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

With the hierarchy represented in Table 3, the evaluators are requested to allocate 100 points between the alternatives on each of the branches. In here, it is reasonable to express views on the relative importance of the topics. The main question in our concern has been, whether actual RTD efforts are fairly tradable or comparable with the networking. However, the formation of new collaborative networks often requires substantial set-up costs and the time spent on e.g. seminars has to be cut off from the research work. Another concern is the completeness of the hierarchy. We do not allow the structure to change, so the threat of a structural splitting bias is eliminated. But again, if the existing hierarchy does not satisfy a DM, it might be difficult for he or she to use it properly.
5.3 Implementation in practice

After creating the structures of the value trees, the implementation of the analysis requires weight elicitation. This again is not that simple and straightforward, as there are no ‘right’ ones or ‘best’ ones among the methods. The exact purpose of the respective phase of the analysis has a significant influence on choosing the methods to use. Minimizing possibilities for misunderstanding and unequal interpretations sets requirements for the method. Besides behavioral aspects, technical facilities and time limitations must be taken into account when considering the elicitation procedures.

The present day value tree analysis theory offers a wide variety of weighting methods, some of which simple and straightforward, some further developed, more flexible and computationally more complicated. Despite the advantages of the partial information methods, for example, considering the weighting in this case, i.e. basically with highly limited time and large amount of participants, the simplest – and thus the quickest - ones of the methods come up again. It is yet better to use a simple method properly than a more complicated one hurriedly: Pöyhönen and Hämäläinen (2000) state, that the increased awareness of the methods decreases the biases occurred. Furthermore, in the Wood Wisdom evaluation, the aim of the weighting is on allocating resources, e.g. “share 100% among the following”, than on determining the preference order of the attributes.

Thus, the SMARTER method is out of question. The cardinal ranking-based methods SWING and SMART would theoretically be applicable. However, Pöyhönen and Hämäläinen (2001) have found, that also with cardinal methods, people are actually prone to expressing ordinal preference information only. Furthermore, the approach of the above, with fixed ground values of 10 or 100 does not support the idea of resource allocation. With the AHP, the basic approach is again somewhat unsuitable in this kind of context. Another thing concerning the AHP is time, as discussed in Section 4.3.2. The aim of gathering information instead of promoting consensus or seeking the dominant alternative, decreases the invitation of using the time-consuming interval methods.

As the sets of criteria to be weighted simultaneously are fairly small and the intended approach is allocation by nature, the Direct-weighting of the Web-HIPRE or some kind
of informal voting, implemented with the Opinions Online, would be the most suitable weighting method. No matter the method, allocating percentage shares between the topics should be theoretically transparent to the evaluators, thus being bias-free without time-consuming consultancy. The yet insufficient group features of the Web-HIPRE tip the balance in favour of Opinions Online voting. With the Web-HIPRE, it is impossible to aggregate the weights. With the Opinions Online, the aggregation is simple, but there is a threat of losing information. After all, revealing and studying the differences in the statements is important in this kind of evaluation. On some of its formats, the Opinions Online offers a possibility of studying more than the simple average of the statements. This is an important feature, because the average basically loses the differences, and may thus produce worthless or even misconceived information.

Referring to the shortcomings of the Opinion Online rating format (see Section 4.4.2) and considering the poor usability averages, a multiple choice-based weight elicitation method would be the most suitable with these technical facilities available. However, in the case of allocation, this approach allows only two criteria to be considered simultaneously. Then the multiple choice alternatives would be close to those of the AHP, e.g. 100/0, 70/30, 50/50, 30/70, 0/100 when considering the allocation of one hundred between basic research / applied research for example. The restriction of two criteria on each branch might turn out to be too strict in our case. Thus, the final weight elicitation method is still under consideration, but will most probably be implemented with Opinions Online.
6 Conclusions

With the boundary conditions set by the nature of the Wood Wisdom programme and the practical issues concerning the workshops, we have not reached a ‘breakthrough’ with the value tree analysis. The basic approach of a comprehensive analysis, i.e., to calculate a strict numerical overall value for the alternatives, is unsuitable for ex post evaluation of a diverse cluster programme. In our case, the main barrier is that the relevant topics make the concepts of weighting and additivity seem uncomfortable. Thus, the ability of the analysis to deal with conflicting objectives cannot be exploited to its full extent. Furthermore, as no quantitative numerical data is available, requiring numerical evaluation statements against the criteria would lead to highly sensitive and controversial results. However, the problem built into a hierarchical structure should promote the evaluators to consider the situation as a whole. Getting the evaluators to parallel the RTD gains and networking promotion is an example of such promotion. The use of the decision frameworks should also be enriched with discussion, both criticism and supplements. Thus, the gains other than strict numerical use suggest that some form of the analysis might still promote the ex post evaluation as well.

In the ex ante evaluation of the programme, the numerical analysis would seem suitable. Describing the various objectives of a forthcoming programme in a value tree, the focal areas may be elicited in terms of resource allocation. Structuring a comprehensive tree and choosing the weight elicitation procedures with prevailing time- and technical restrictions yet remain challenging. But in general, for promoting the ex ante evaluation, the value tree analysis seems more promising.

Widening the use of the analysis would require two ways of deeper interaction: In the preparation phase, the programme representatives should strongly bring in their knowledge about the programme in order to create a more comprehensive value tree. Alternatively, or rather additionally, the implementation phase should allow close interaction with the evaluators in order to allow the evaluators to contribute the structure of the tree and deepen their knowledge of the method implemented. Interval methods,
dealing with uncertainties, may then be the answer for the problem of converting the subjective statements into numbers.
7 References

7.1 Literature


### 7.2 Internet resources

Wood Wisdom programme

http://www.woodwisdom.fii

Web-HIPRE

http://www.hipre.hut.fi

Opinions Online

http://www.opinions.hut.fi

Decisionarium – Software Related to MCDM

http://www.decisionarium.hut.fi

Lake Päijänne case

http://www.paijanne.hut.fi