Dissertationes Forestales 17

Creating value through advanced silvicultural services

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Academic dissertation

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ABSTRACT

A scenario study was used for creating alternative operational environments for wood production in Finland in the future. The most promising research topics in the alternative scenarios were then analyzed and summarized. The alienation of non-industrial private forest landowners from practical forestry, the need to foster entrepreneurship, and the need to improve cost-efficiency in silvicultural service provision were found to be the most important background factors. Also, counteracting the effects of threatening lack of labour for silvicultural works safeguards the future of wood production. Based on these results, theories on creating value through services were applied in order to develop a service chain for stand establishment and management of young stands of Norway spruce.

The first step in the service chain was that of quality-guaranteed stand establishment service, where the establishment of a tree stand is sold to the customer as a total service commodity. The idea is that the service provider bears the risk of failure of stand establishment up to a certain stand age. Adequate premiums for covering the risk of failure were calculated.

The second step involved looking into the possibilities of classifying established Norway spruce stands according to their potential for emerging need to undergo early tending within six years after planting. Reliable prediction of the need for early tending turned out to be impossible, despite the use of state-of-the-art classification algorithms.

The third step was to study the effect of timing of tending on the consumption of working time in young Norway spruce stands. The common problem of great variation between sample plots in time studies was avoided by introducing a new method. Just a brief two-year time span between the alternative timing points of pre-commercial thinning resulted in marked changes in the consumption of working time. The simulated effects on the further development of the stands did not differ much from one another.

The effective use of examples of such services, as presented in this study, requires information and communication technology applications for the management of stand and operational information.

Keywords: cleaning, management of young stands, Norway spruce, planting, pre-commercial thinning, quality, stand establishment, tending

PREFACE

This dissertation is one outcome of the research work done on silvicultural technology at Suonenjoki Research Station. I launched into this work at the beginning of 2001 in the capacity of an adjunct researcher, and as of August 2001 continued with the work as a full-time researcher.

Professor Pertti Harstela has been my supervisor and he also co-authored Article I. I am particularly grateful to him as he infused me with courage when the going got tough. I also wish thank the co-authors of Article IV, Mr Simo Kaila, Mr Antti Miettinen and Dr Sauli Valkonen for their valuable work. The other researchers and members of the Silvicultural Technology Group at Suonenjoki Research station; Dr Juho Rantala, Dr Pekka Helenius and Mr Veli-Matti Saarinen, have helped me in many ways during the last four years in completing the dissertation. Methodological issues have been easier to solve in a group of researchers with its diversity of knowledge on research methods and scientific disciplines. The director of the research unit, Dr Heikki Smolander, provided ideas for research and enthusiastically supported this work. He also read the manuscript before the review process. Professor Pekka Mäkinen and Dr Dan Glöde pre-examined the manuscript and gave further advice regarding slight improvements before this thesis is defended in public. Mr Erkki Pekkinen checked the English language.

I would also like to thank Prof. Matti Kärkkäinen, Prof. Jyrki Kettunen, Dr Tarja Meristö, Mr Jukka Nerg, Mr Pekka Paakkinen, Prof. Pasi Puttonen and Mr Pentti Savolainen, for the innovative atmosphere they created during the scenario process, whichactually provided the starting point for the entire study.

Funding from Marjatta and Eino Kolli Foundation played a key role in the implementation of this study and the Foundation continues to provide me with a wonderful opportunity to continue my research work after this dissertation.

Thanks also go to my parents for letting me perform various silvicultural treatments in their forest. Practical silviculture has powerfully stimulated scientific work and vice versa. Although the practical operations were sometimes interrupted by the worker's scientific thinking, I am sure that this dissertation has conversely boosted the profitability of forestry at one forest holding in Southern Savo.

Thanks to Niina, Anni and Harri, and the best nieces in the world, Iina and Nanna, for providing non-scientific activities during these years.

Suonenjoki, March 2006

Nuutti Kiljunen

LIST OF ORIGINAL ARTICLES

I Kiljunen, N. & Harstela, P. 2005. Alternative futures for wood production in Finland. Manuscript.

II Kiljunen, N. 2005. Pricing the risk of the quality-guarantee in a stand establishment service. Silva Fennica 39(1): 81-88.

III Kiljunen, N. 2004. Prediction of need for early tending in Norway spruce plantations. Baltic Forestry 10(2): 56-60.

IV Kaila, S., Kiljunen, N., Miettinen, A. & Valkonen, S. 2005. Effect of timing of pre-commercial thinning on the consumption of working time in *Picea abies* stands in Finland. Manuscript.

Paper I: Kiljunen wrote the manuscript based on the results of scenario work. Harstela managed the project and helped in writing the manuscript.

Paper IV: Kaila provided the key idea of the study and planned the guidelines for the whole study. Kiljunen planned and participated in the field work and wrote most of the manuscript. Miettinen calculated the simulations. Valkonen planned the simulation analysis and wrote those parts of the manuscript which concern simulation methods and results.

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1 INTRODUCTION

1.1 The role of business and service provision in wood production

The basis of silviculture relies on biological and ecological aspects, which form the core for the whole activity (Figure 1). Silviculture is the control of the establishment, growth, composition, and quality of forest vegetation aimed at defined management objectives (Daniel et al. 1979, Kellomäki 1991). To reach the desired silvicultural objectives, technology is needed to produce methods to implement the procedures in practice. The next step is to extend the scope into business, to give context to the silvicultural operations and services carried sold to forest owners. The inner layers provide the foundation for the outer layers. Whatever is done on the outer layer, the requirements for the activity are set by the the inner layers. There are also legal, social and political factors and norms affecting the silvicultural business (Daniel et al. 1979).

Silvicultural operations as a service business have played a minor role in research, compared to the wide range of extensive research in previously mentioned ecological, methodological and technological aspects of silviculture. During the past decade, some surveys were carried out among service providers in Finland, partly also representing the spreading of service provision from local forest owners' associations (FOAs) and other organizations to private entrepreneurs (Viitala 1994, Koistinen 1999, Kärhä 2000, Kärhä et al. 2000). There are also previous studies where the use of the services, including extension services, has been surveyed among different forest-owner groups (Partanen 2000, Kettunen & Kärki 2004).

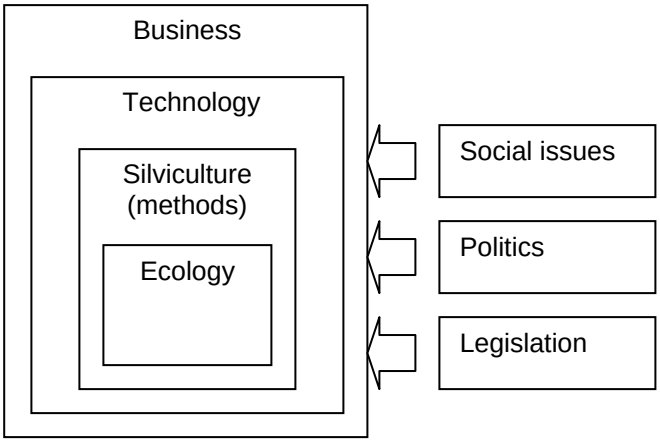

Figure 1. Elements of silvicultural services.

Despite the entrepreneurship that has emerged in silviculture, most silvicultural services sold to non-industrial private forest (NIPF) landowners in Finland have been offered by FOAs (Ruohola 2005). The latter are organizations of NIPF landowners and act as trustees and service providers for their member forest landowners. Their position and tasks have been outlined in the legislation (Laki metsänhoitoyhdistyksistä 1998), which has probably more or less monopolized the service provision situation in small-scale forestry. In addition to FOAs and small-scale private entrepreneurs, also wood production enterprises and forest industry companies provide silvicultural services to NIPF landowners. All the service providers in practice often use sub-contractors for operations (Kärhä et al. 2000).

A challenging feature of the marketing of silvicultural services is the wide diversity of customers. There are about 300,000 NIPF holdings over 5 ha in area in Finland (Finnish statistical… 2004). The structure of NIPF ownership has markedly changed in Finland during the past few decades (Ihalainen 1992, Ovaskainen & Kuuluvainen 1994, Karppinen, et al. 2002). The trend has been towards female, older, and non-farmer owners increasing in number (Karppinen et al. 2002). Half of all NIPF landowners, however, still lived on their farms in 2000 (Karppinen et al. 2002). Despite the large proportion of forest owners living outside their holdings, there is a large number of at least part-time self-employed forest landowners, who are interested in doing silvicultural work in their forests (Kettunen & Kärki 2004, Koho et al. 2004). The objectives of NIPF landowners vary greatly, but most of these people are multi-objective or economically-oriented landowners (Lindroos 2005)

Segmentation of customers is a key issue in modern marketing (Kotler & Keller 2006). The idea is to chance the marketing approach from mass provision of homogenous services or products to provision of services adapted for different customer groups. In NIPF forestry, segmentation has been studied from the buyer's perspective concerning landowners selling timber to sawmills (Sikanen 1999). Partanen (2000) broadened the scope to cover the entire relationship between a forest-industry company buying timber and providing silvicultural services. That study provided some ideas also for this research to create new service approaches.

New marketing and production economic approaches to silvicultural service development are also well grounded because of emerging cost pressures in the business in a changing operational environment (Harstela et al. 2001). By launching new or renewed products or services, suppliers are aiming for economic success (Rope 1999). New service approaches can be related to marketing operations; for instance, FOAs have created a chain of service providers to improve the availability of their services among NIPF landowners throughout the country to enable better availability of their services (MTK 2002). Also, a more traditional approach to improve operational cost efficiency by new methods in silvicultural work can boost service provision.

In business-to-business (B-to-B) marketing, the trend has been towards a service-oriented approach to customers' needs (Vandermerwe 1993, Ulaga 2003, Rope 2004). The weight between the core product, the service directly related to it, and the utility have changed (Figure 2). The importance of value- or utility-creating services added to products has greatly increased. Development towards the service-oriented approach in customer-relations management has also been evident in business-to-consumer (B-to-C) marketing (Grönroos 2001). An even more thorough approach to service-oriented customer relations management (CRM) is the marketing of total solutions to the customer (Kaario et al. 2003). A similar development has started in silviculture, but so far the issue at stake has usually been the only transaction of the operation, and when necessary, including the core product itself (e.g. seeds or seedlings). Such a traditional approach relates closely to the product

concept in marketing (Kotler and Keller 2006). Recent research topics on the marketing of services for forest landowners have been, for example, the segmentation of customer groups and comparison of alternative marketing channels (Kettunen & Kärki 2004). Partanen (2000) also included several silvicultural issues in a survey study concerning forestry services offered to NIPF landowners. The most thorough studies on the management of business relations with NIPF landowners have been done from the standpoint of timber procurement (e.g. Kärhä 1998).

1.2 Topic of the study

The topic of this dissertation was chosen to be silvicultural services from the perspective of production economics. To be more precise, the development of the service provision and of new service types was taken as the objects of closer examination. The purpose was to adopt a new approach to silvicultural services.

It was thought necessary to use some method to outline and analyze the research problem. To improve the relevance of the more detailed research topics in a changing operational environment, the first aim was to recognize, analytically, the issues having potential importance for the needs of silvicultural service development. With this in mind, a scenario study was first used for creating alternative operational environments for wood production in Finland in the future (I). For this dissertation, it was anticipated that the results of the scenario study would provide a basis for further ideas of silvicultural service forms and service entities. The final formulation of the research plan was done after reviewing the findings of the scenario study. This final formulation is presented in Chapter 3 after the summary of the scenario study.

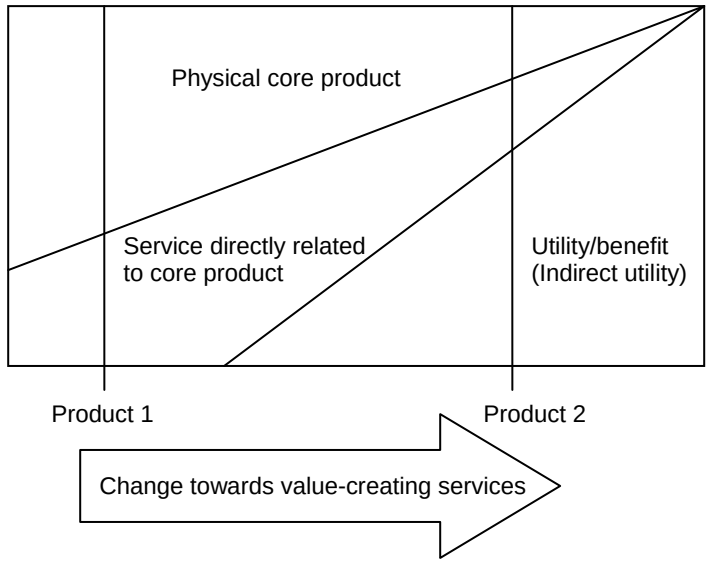

Figure 2. Model for product elements changing in the direction of value-creating services (modified from Rope 2004). Product 1 contains mostly the core product and a directly related service, while Product 2 also contains indirect utilities.

2 SCENARIOS FOR WOOD PRODUCTION

2.1 Methodology

A scenario is simply a description of the future (Meristö 1989). Using scenarios for forecasting has become very common in futures science (FS) (Bunn & Salo 1993). The expert panel method for constructions of scenarios has been widely used in FS especially in technology forecasting (Mannermaa 1993, Eerola & Jørgensen 2003). Multiple scenarios are often constructed to create and describe different alternative futures for decision making. Predicting the future by using trends based on the past, and on other similar models, was common some decades ago during the era of stable economic growth; but it has since then became obvious that unpredictable changes can occur, changes requiring a more visionary approach (Ansoff 1979, Amara 1981). Ansoff (1979) has called such a situation 'turbulence'. The major implication of turbulence is that the unexpected nature of events is increasing such that the outcomes rely less on previous experience in planning for the future than before.

Qualitative scenarios are used when there are no data available for making forecasts or when the quality or usability of data is poor. Qualitative scenarios are usually based on narratives, while quantitative scenarios are typically based on models. Model-based quantitative scenarios often involve the use of computer models, either as the central means of exploring the future consequences of sets of assumptions or as tools for checking the consistency of the developed scenario (Rotmans et al. 2000). Alternative qualitative scenarios allow us to take into consideration unexpected fundamental changes that are difficult to forecast with models based on quantitative data (Meristö 1989). Examples of such changes are technological changes caused by innovations that quickly make obsolete old technology or societal changes caused by political events.

The task of scenarios, no matter how they have been created, is to act as tools (Bunn & Salo 1993). They are not an end to themselves, but they are necessary for further planning of activities. This is especially important in strategic business management. The purpose of scenarios is not to search for the "ultimate truth" about the future, but rather to support decision-making in the present situation: to prevent threats and promote desirable development (Linturi et al. 1998). Such an approach powerfully emphasizes that future outcomes can be influenced by individual choices. Amara (1981) proposed that although the future is neither predetermined nor predictable, it can be influenced.

Meristö's (1989, 1991) framework for scenario analysis was used in this study. It is a typical method utilizing an approach with multiple scenarios. Large-scale global scenarios constructed by the World Business Council for Sustainable Development (Exploring sustainable… 1997) and The Royal Dutch/Shell Group (Shell 1995) were used as the background for the scenarios created in this study (Table 1). The scenarios for the Finnish forest cluster created by Meristö et al. (2000) were also used as the basis for the scenarios created.

The created scenarios themselves are not very useful. If they are well created, they should indicate the need for flexibility in changing future, but combining them into a broader framework of long-range planning helps to get more out of them. Figure 3 presents the relationships between scenarios and other factors related to long-range planning according to Meristö 1990 and Meristö et al. (2000). Vision is the desired state of future that the strategy and its operationalization aim to attain. Scenarios do not necessary lead to

a vision. Navigation marks are set for the scenarios to indicate the direction of development and to act as incentives for re-thinking of strategy or vision (Meristö et al. 2000).

Table 1. Keywords of the global scenarios used as the background for the study.

Just Do It	**Da Wo**	**FROG!**	**GEOpolity**	**Jazz**
Shell (1995)		Exploring sustainable… (1997)		
Libertarianism	Governments matter	Shortening horizons	Non-market values shape development	Market and technological innovations
Hyper-competition	Increasing returns	Ineffective institutions	New governance forms	Alliances and social experiments
Dematerializa-tion	Building long-term advantage	Missed signals	Global standards	Sustainable development as "best practice"
Individualism	Cohesion			
Bubbles of value	Being Asian			

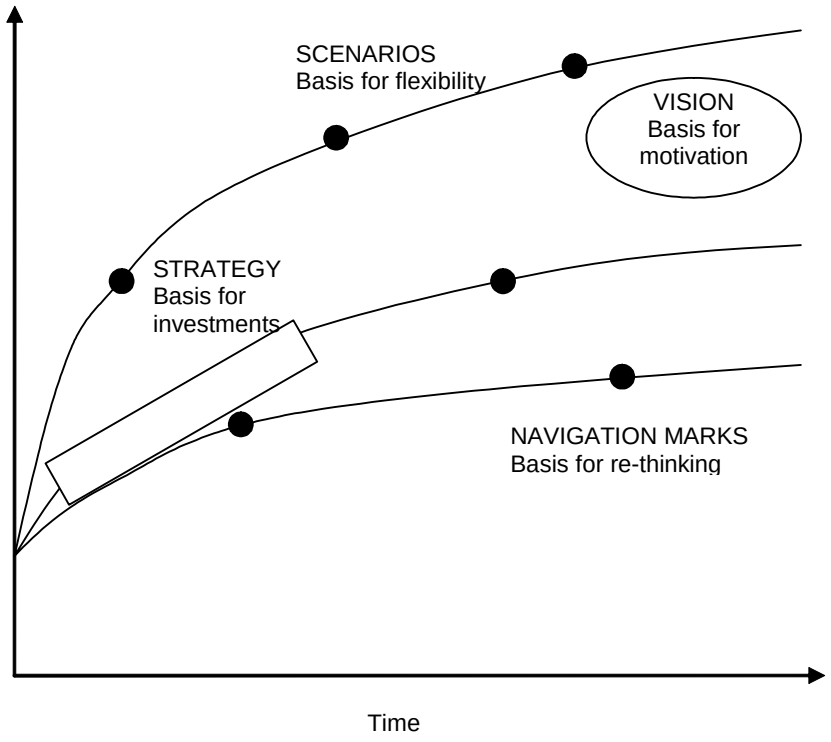

Figure 3. Relations between scenarios, strategy and vision (redrawn and translated from Meristö et al. 2000).

The time-scale of the scenarios was set at about 20 years. This was considered to be enough to allow a “take-off” from the current way of thinking, but the current state of the forests and forest industries still forms the basis for the analysis.

2.2 Scenario construction and recognized research needs

In the beginning of scenario construction, the group had listed issues that were supposed to remain constant in every alternative version of the future. After the construction of scenarios, these “basic beliefs” were considered in every scenario. After the scenario construction, it became evident that only a few basic beliefs were possible in all of the scenarios. Most of them, however, were possible at least in most of the scenarios. The strongest beliefs were:

- Private forest ownership will remain important in the future
- The productivity of operations can be increased by information and communication technology (ICT)
- There will be changes in the structure of Finnish NIPF ownership, such as polarized size-distribution of holdings, landowners not living on their holdings and aging landowners
- There will be difficulties in recruiting labour for forestry operations
- People, including NIPF landowners, will become estranged from practical forestry

After considering the basic beliefs, the panel group sketched twelve preliminary scenarios in free form. By combining some of these preliminary scenarios, six final scenarios were finally formulated, each by one or two of the group members. Group discussions were used in attempting to diminish the bias caused by the personal opinions of individual group members. The final six scenarios were as follows:

I "The Great escape of forest industries" – the pulp and paper industry recession in Finland and the other Nordic countries
II "Green business" – nature reserve forestry takes place as wood loses its importance as raw material
III "Forest industries take it all" – globalizing forest industries have their home base in the Nordic countries, but production in the home base may decrease
IV "A Wooden house is a status symbol" – a long-lasting boom in modern wood construction
V "Make your own business" – technology-oriented companies related to wood production succeed
VI "Business-oriented forestry" – reformulated national forest policy and fair business practices

A broad-in-scope description of the contents of the created scenarios is reported in Harstela et al. (2001).

The total demand on the roundwood markets varied from a scenario to another. The critical issue for future wood production in Finland is what happens to the forest industries and their structure of production. The success of either mechanical or chemical forest industries will affect the demand for different wood assortments and their stumpage prices. Scenarios III, IV and VI had the largest total demand for roundwood. Large-diameter sawlogs of good quality enjoyed some demand even in the worst scenarios, where the total

demand for roundwood drastically decreased from its current level. The demand for roundwood obviously has a fundamental effect on wood production as a form of business. In most scenarios, the stumpage prices decreased from their current level. To maintain the profitability of wood production, some counteracting measures have to be performed. As the price level of wood in the various countries around the Baltic Sea has been converging, it is difficult to influence stumpage price levels nationally. To keep up the profitability of wood production, at least the costs of silvicultural operations in wood production should be decreased.

Another major issue, in addition to the demand for wood, noticed concerning wood production in Finland in the future was that of motivation of NIPF landowners. The divergent motives and preferences of current and future NIPF landowners in regard to practical forestry may emphasize the demand for service-oriented approach in customer-relationship management. To ensure the profitability of the produced services, improvement of the cost-efficiency of the services is a key issue. At the same time, the quality of the produced services plays an important role. The principles of industrial engineering and management should be applied to service development. Especially logistics and advanced ICT-based management systems may hold great potential for the future development of silvicultural services (Åkerman 2001), although improved logistics in wood harvesting is no longer seen as so promising a means of competition (Kolström & Harstela 2005). New service entrepreneurship utilizing ICT application may improve the cost-quality ratio in silvicultural services. So far, for example, the monopolized allocation of forest management fees has been seen as a permanent market disturbance (Kolström & Harstela 2005).

Other forms of using forests, such as production of wood for energy, were assigned varying importance in different scenarios. However, they were less important than the production of industrial roundwood. Therefore, the importance of other forms of using forests from the standpoint of service production was assessed to be distinctly smaller than that of wood production.

Lack of labour in forest operations has been said to be a serious future societal threat in several contexts (Harstela et al. 2001, Immonen 2003, Työvoiman saatavuus… 2005). Considering wood production, this could cause serious problems, even if the other preconditions for successful business are in order. Entrepreneurship has sometimes been mentioned as a means of encouragement for forestry work. In forestry operations, at least in harvesting, entrepreneurship has been seen as an object of considerable respect by society in general and by the families of the entrepreneurs in particular (Kanninen 1996). If the impending labour shortage eventuates, the productivity of work may increase in importance in silvicultural operations, compared to cost-efficiency, although they are usually powerfully correlated with each other. Activities towards resource-saving operations and maintaining recruitment are both needed for practical forest operations if wood as raw material is still to maintain its current demand.

In most of the scenarios, the role of the government and society in wood production is to promote the implementation of forest policy and supervise compliance with forestry legislation. The role of governmental organizations in service provision, however, will be that of the buyer of services instead of the practical producer (Metsänomistajien neuvonnan… 2002). The Government's subsidies to wood production should be carefully allocated to ensure their effectiveness as a means of forest policy (Riihinen & Järveläinen 2004).

3 FORMULATION OF THE RESEARCH TASK

The results of the scenario project were refined to yield more specific research tasks considering services aimed at NIPF landowners. The most noteworthy issues emerged from the scenarios and needing research input were as follows:

- Estrangement of NIPF landowners from practical forestry
- Need to foster entrepreneurship in silvicultural service provision
- Need to improve cost-efficiency in silvicultural service provision
- Counteract the effects caused by the threatening labour shortage in silvicultural operations

A further aim of the study was to develop tools and methods for silvicultural service production to meet the challenges arising from the scenario study within the framework of business economics. The approach chosen here is based on the theories on the creation of value in business relations (e.g. Vandermerwe 1993, Ulaga 2003, Kaario et al. 2003). Both customer and supplier viewpoints on the creation of value were included. Theories of value creation were used in choosing and reshaping the final research topics. Although creating or selling value has become a key issue of service marketing in modern business economics, this approach has not yet been used in research looking into silvicultural services. The business-to-business (B-to-B) approach to marketing was chosen on purpose here, although business-to-consumer (B-to-C) approach could have also been applied because of the small scale business of typical of Finnish NIPF landowners. Concentration on the wood raw material production aspect in silviculture led to the decision to use the B-to-B approach.

The basic idea was that motivating and activating of NIPF landowners for wood production could be beneficial through the value-creating service provision. New types of services could also be attractive to customers no longer familiar with the practical side of wood production (Partanen 2000). The approach chosen could also be an initiative for a new type of entrepreneurship exploiting the competitive advantage offered by advanced service concepts. Increased competition in previously fairly low-competition business and improvement of the cost-efficiency of the operations are possible solutions to the challenge to reduce wood production costs. Including both customer and supplier viewpoints in the study creates a dual approach to the study of the business process.

Figure 4 describes the structure of the dissertation. After the formulation of the research task, the theories used for supplier and customer value are presented. A more detailed extension of the value creation theories into the research topics is represented at the beginning of Chapters 4-6 which summarize the sub-studies in Articles II – IV. Articles II, III, and IV were planned to form a value-creating service concept from stand establishment to the subsequent phases in the management of young stands.

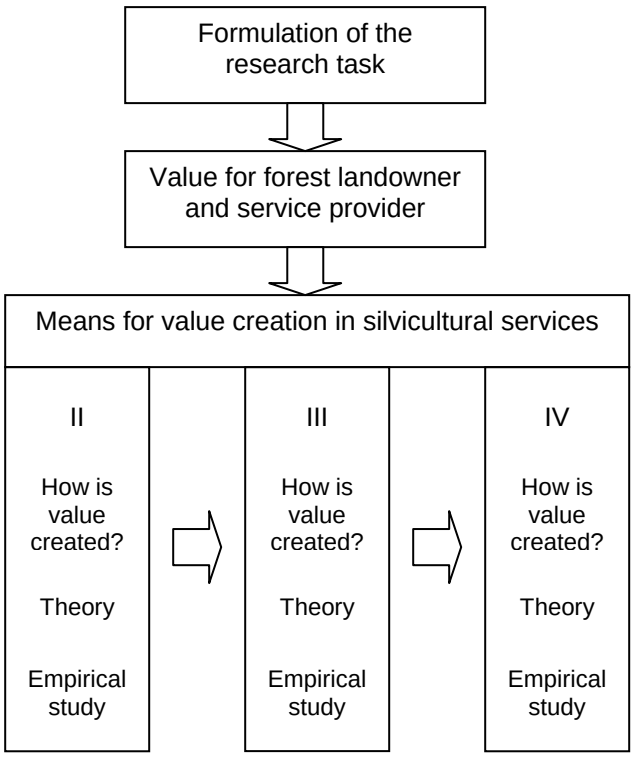

Figure 4. The structure of the dissertation onward from the formulation of research task. The Roman numerals refer to the summaries of Articles II-IV reported in Chapters 4-6. The horizontal arrows between the articles describe the chronological order of service operations.

3.1 Customer value

The customer value approach in this study is based on Ulaga's and Eggert's (2003) and Ulaga's (2003) approach on relationship value (Figure 5). It goes deeper into the customer's role and experience in a business relationship than the plain customer satisfaction approach. The bases of this approach are the dimensions of relationship value, which are either sacrifices or benefits to the customer. Customer sacrifices are the overall monetary and non-monetary costs (i.e. time, energy and effort) that the customer invests in getting the product or service, or in maintaining the relationship with the company. Conversely, customer benefits are all the monetary revenues and other utilities that the customer obtains from the business relationship. Ulaga (2003) presented more comprehensive contents for the relationship value (Figure 6).

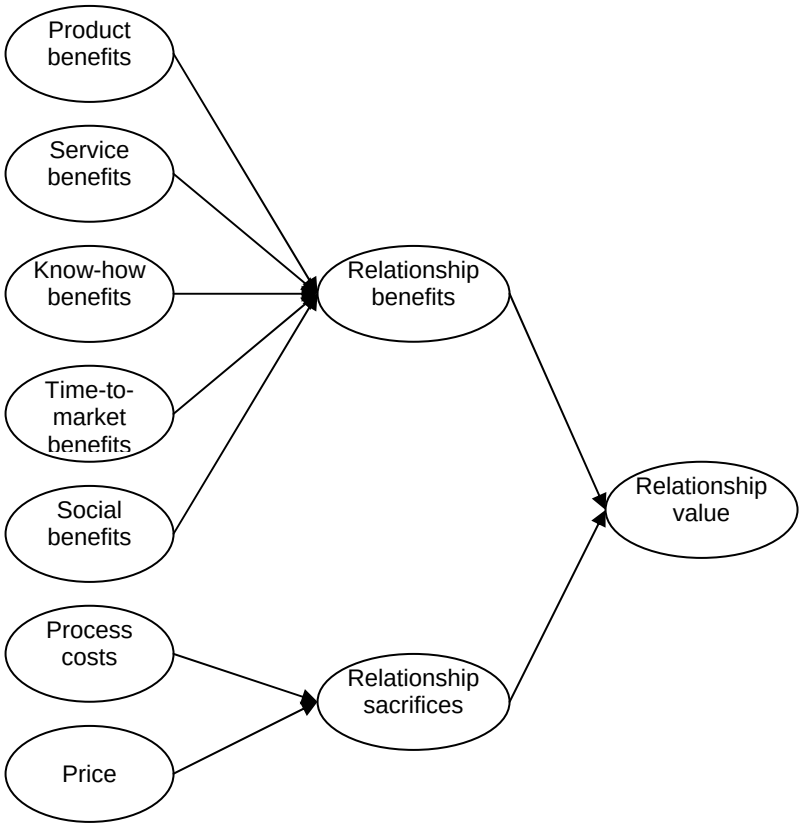

Figure 5. Conceptualization of relationship value (Ulaga & Eggert 2003).

Spiteri and Dion (2004) tested empirically the model for customer value variable proposed by Eggert and Ulaga (2002) in a hybrid veterinary pharmaceutical market. The model is slightly different from the one in Figure 5, but the most important relationships and elements are the same. The good performance of the model in that study encouraged me to use a similar theory in this work.

Product quality in silvicultural services may be regarded as the quality of seed, seedlings and other material provided to the customer. The product itself is the core of relationship value (Homburg & Rudolph, 2001). In the providing of silvicultural services, such products are usually not produced by the service provider itself, but the service provider instead acts as a middleman adding services to the supplied products. In large-scale operation, the products themselves, supplied by different service providers, are more or less the same, because practically all silvicultural service providers have access to the silvicultural material in the markets. Silvicultural operations as plain production without any value-adding services, such as tending of certain areas, could also be seen as the core product.

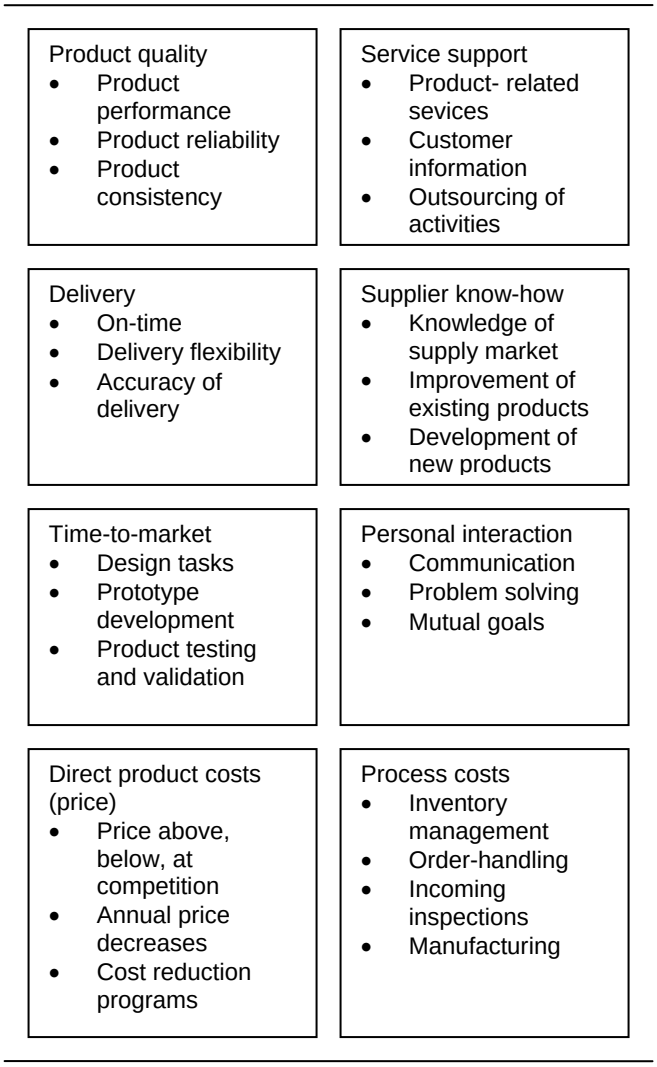

Figure 6. Dimensions of the relationship value (Ulaga 2003).

The service support dimension of the relationship value in silvicultural services may relate to the work itself done in the forest, e.g. operations related to stand establishment, cleaning, etc. The operation itself, i.e. the plain work produced, does not necessarily differ very much from one producer to another, if the service producers are qualified professionals. The work methods are usually more or less the same in stand establishment and cleaning. As mentioned above, the plain operation produced can also be considered to be the core product instead of service support. A wider approach to service support is, for example, provision of after-sales marketing or information support. Know-how in applying silvicultural methods, however, may differ markedly (Kalland 2002). In addition,

motivation and instruction of the forest owner by the service provider for self-service can be regarded as a form of service support (Kettunen & Kärki 2004).

The know-how dimension takes into account how professionally the service provision is carried out as a whole and how the current operational manners are developed and new ones created. Previous studies have demonstrated that there are clear differences in know-how between the service providers regarding the manner in which different work methods are applied and the results achieved. One example demonstrated the uneven results in forest regeneration between FOAs in Finland (Saksa et al. 2002).

Delivery, and its flexibility, timing and accuracy play key role also in silvicultural operations. In stand establishment, the timing of soil preparation, the handling and delivery of seedlings, and the timing of planting can have a marked effect on the results (Helenius et al. 2002a, 2002b). In tending, timing is essential for the vitality, quality and growth of the main tree crop (Varmola & Salminen 2004).

The effect of the time-to-market dimension may not be as short-sighted in silviculture as, for example, in the manufacturing industry. There are, however, changes in the business that require quick responses from service providers. In Finland, for example, the increased use of wood for energy could be seen as a phenomenon where the time-to-market dimension is important for ensuring the availability of the appropriate services to customers. Another issue in this dimension could be support for the forest owner in producing a wider range of timber assortments for which there is good demand. Means of such support are, for instance, services related to fertilization and forest management planning (Harstela 2004).

Personal interaction has traditionally been a key issue in provision of silvicultural services. As regards Finnish NIPF landowners, personal contacts are the most pleasant manner of getting advice in forest management (Karppinen et al. 2002.). Personal interaction is supremely important for the previously mentioned activation of forest owners to engage in self-service in silviculture (Kettunen & Kärki 2004). Personal interaction is also important in constructing and maintaining trust in business relationships also in B-to-B marketing (Gounaris 2005). Trust and trustworthiness in business relations have been identified as important factors in economic performance (Bohnet & Croson 2004).

The customer sacrifices consist of two dimensions; direct product costs (i.e. the price of the purchased service) and the process costs that are costs, other than price, related to the purchase. In silvicultural service relationship, it is easy to imagine a trade-off between the price and the process costs. Two CRM approaches respective to such a trade-off thinking are the service approach and the price approach (Grönroos 2001). The service provider may carry out all operations included in a service product for a certain price. Another option is that a self-employed forest landowner pays a smaller price, but does some of the work himself. In such a situation the process costs are higher.

3.2 Supplier value

Most of the research on value-creation in B-to-B marketing today focuses on the customer-value perspective. Knowing where the value resides from the standpoint of the customer has become critical for suppliers (Ulaga & Chacour 2001). In this study, the supplier-value standpoint was also included in the study to improve the usefulness of the tools created for the supplier. Kärhä et al. (2000) studied the success factors of silvicultural service entrepreneurs in Finland. The study provides a useful starting point for examining the

supplier viewpoint in the silvicultural service business emphasizing the need for a strategy to improve the profitability of the business. Vandermerwe (1993) presented a list for creating added value through services, which provides a suitable framework for the supplier-value approach. She listed the following ways in which value-added services could pay off for the service provider:

- Greater portion of revenue may come from these services
- Firms increase their know-how capability by providing services, thereby increasing their assets
- Performing services for customers creates a valuable bonding
- Services also lead to a high degree of repeat business, thus reducing overall costs
- Through value-added services customer spending increases
- Services permit higher prices to be set on core offerings
- Value added from services increases the percentage of market obtained
- The firm's percentage of its own customers' business goes up because of the services offered.

Most issues from Vandermerwe's (1993) list were of use for the further implementation of the study. Some of them are typical for the most successful entrepreneurs, such as the aim of achieving strong bonding with customers (Kärhä et al. 2000). The current practices in silvicultural service marketing have not as yet gained any real competitive edge when looking at the list as a whole.

A typical phenomenon for B-to-B markets in the manufacturing industry has been the convergence of supplier and customer (Vandermerwe 1993, Kaario et al. 2003). The business relationship has developed from a purely transactional one, through relational and interactive phases, to one with a connective nature. The last phase is often called the co-creation of value (Prahalad and Ramaswamy 2004). The utilization of ICT in the management of the business relation for co- creation of value is usually a key issue. A broad-in-scope review of productivity gains achieved by ICT-linked firm reorganization has been presented by Falk (2005). In the case of silvicultural services, such an ICT approach can be described as the customer's activity cycle (Vandermerwe 1993) to illustrate the usability of a data management system (Figure 7). In forestry, an ICT application could, for instance, be an updateable forest management plan implemented by the service supplier's application hosting service. In such a concept, both supplier and customer would have direct access to all the information in the management plan. Such an approach has successfully been utilized, for example, in the manufacturing industry and the wholesale trade (Vandermerwe 1993). That approach also related closely to CRM, which methodology has been reviewed by Chalmeta (2005). Currie and Parikh (2005) provided an integrated model for value creation in web services. They introduce the idea of how competitive advantage can be obtained using the web as a service tool. Basic ideas for the contents of an updateable forest management planning system as a tool for management of operations have been presented by Kalland and Harstela (2003).

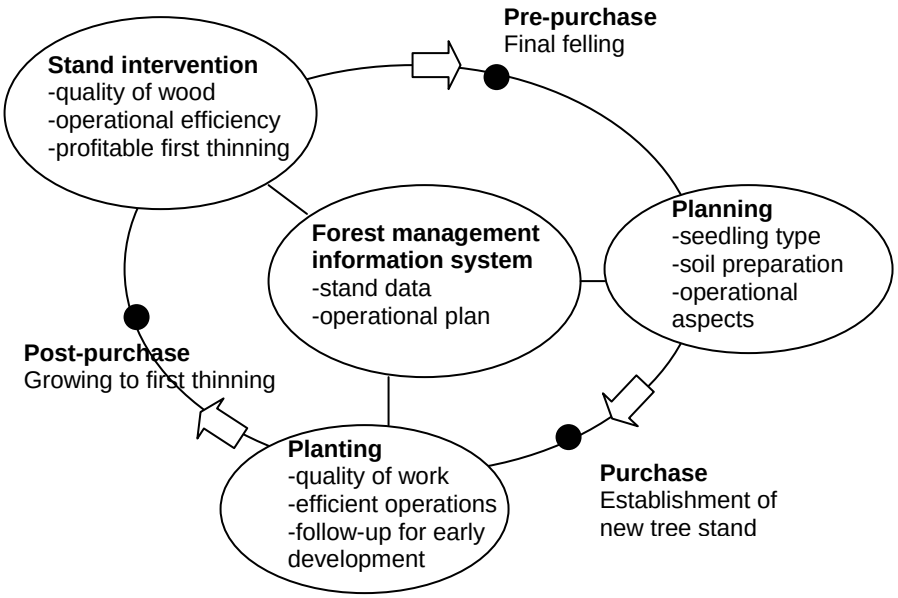

Figure 7. Customer's activity cycle (Vandermerwe 1993) as applied to stand establishment and management of young stands.

3.3 From value theories to detailed research tasks

Using the aforementioned theories for the creation of customer and supplier value, a comprehensive service concept for management of young stands was outlined to cover stand development from establishment through tendings or pre-commercial thinnings to first commercial thinning. The study provides a model for close collaborative relationship between the NIPF landowner as customer and the silvicultural service provider as supplier. The studied management concept focused on three distinct aspects:

- Quality-guaranteed stand establishment (Article II)
- Prediction of need for early tending (Article III)
- Timing of cleaning and its effect on work productivity (Article IV)

Norway spruce was studied as a case for empirical analysis. This was done to simplify the study task and to concentrate on the tree species whose importance has risen most in wood production in Finland in recent years. Norway spruce has become the most commercially important planted tree species in Finland (Finnish statistical… 2004). The research on management of young Norway spruce stands has played a somewhat smaller role to that of Scots pine (Harstela 2003). Moreover, the results of the scenario study supported the research input for Norway spruce.

The ideas of these research topics and their realization are presented in the following chapters. The elements of customer-value and supplier-value creation under these research topics are described above in the theories of Vandermerwe (1993), Ulaga (2003) and Ulaga and Eggert (2003). A common discussion is presented after the summaries of Articles II-IV.

4 QUALITY-GUARANTEED STAND ESTABLISHMENT SERVICE

4.1 Background and creation of value

Quality-guaranteed service means that the establishment of a tree stand is sold to the customer as a service commodity. The service provider carries the risk of failure in stand establishment up to a certain stand age. The customer "receives" a young stand of good quality after the agreed time of delivery, which in this case is naturally some years. The criteria for the success of complementary planting or a monetary refund will be provided to the customer in the event of failed establishment. To keep the business profitable, the service provider must collect a premium to cover the costs of claims from failed stands.

Such a new type of service approach could be a business concept for new entrepreneurship. It should also motivate the forest owner to actively engage in wood production, which is one of the challenges observed in the scenario study. The customer does not necessarily need extensive knowledge of silviculture and forest management to get good results. It is well known how poorly seemingly cheap regeneration methods, such as natural regeneration of conifers, perform on fertile sites (Saksa et al. 2005). A quality-guaranteed service concept provides an easy way for a NIPF landowner to get adequate regeneration results. It should be noted that forest legislation also imposes requirements on forest regeneration results and management of young stands (Metsälaki 1996).

The created quality-guaranteed service model mainly combines the first three dimensions of the benefits (product, service, and know-how) presented by Ulaga and Eggert (2003) in their model. It also decreases the process costs of the customer, thus partly decreasing customer sacrifices. For NIPF landowners living outside their farms the decrease in process costs may be more important than to farmer landowners living on their property. The price of the service is the amount of the premium exceeding stand establishment costs without any guarantee. In regard to customer sacrifices, the trade-off between the price and the process costs may be important when making the decision to buy.

In the framework of Vandermerwe's (1993) supplier value, the quality-guaranteed stand establishment service can be an example of the services that provide greater revenue than the product itself. Quality-guarantee with regular surveillance and analysis of the stand establishment results also raises the level of knowledge of the service provider, which leads to higher revenues due to decreasing average numbers of failed stands. It can also be seen as a differentiated service product, which creates a competitive advantage in the marketplace and can be a means of gaining a share of the market. Moreover, the quality guarantee service creates valuable bonding between the customer and the service provider, this bonding being based on the choice made by the customer in the marketplace – not on legislative guidance.

4.2 Methodology

The approach applied in this study was based on risk theory and simulation. Risk theory has been developed mostly for insurance purposes. The earliest actuarial techniques were based on average numbers of claims (see Beard et al. 1977). For example, if an insurer has a portfolio of N policies at risk and if the expected mean value of the frequency for these policies during a specific period is q and the expected average size of the claim is m, then the expected total amount of claims is Nqm. A straightforward application to stand

establishment would then be: N = the annual number of established stands, q = the proportion of failed stands, and m = the cost of replanting or of other compensation. The actual number of claims, however, is a random variable, and the actual amounts of claims arising from several successive periods will fluctuate around Nqm.

Such a straightforward approach is the most inappropriate in this case. Instead, the business process of a silvicultural service provider was described as a simulation model emulating actual operations. The simulation was carried out using probability distributions fitted to the data. The survey method for young stands developed by Saksa (2003) and Saksa et al. (2002, 2005) was used. The data consisted of 212 Norway spruce regeneration sites with a total area of 363.2 ha. The success of establishment of stands in the data was analyzed using alternative criteria for success. The respective numbers for seedlings needed for repair planting was also calculated.

Here, the criteria for the success of reforestation are based both on the minimum number of good-quality seedlings per hectare and on the proportion of the area with a low density of good quality-seedlings. Four alternative quality criteria were set for the qualification of a stand. The criteria were based both on the average spacing of the seedlings in the stand and the spacing of seedlings on the worst 20% by area of the stand. The criteria and the respective probabilities of failure are shown in Table 2.

An individual claim was described here as the cost of replanting a failed stand up to a certain target spacing. Repair-planting cost was used as a determinant for the amount of a claim, although successful repair planting of spruce stands may be difficult, at least if the gaps to be repaired are small (Gemmel 1988a, 1988b). In terms of value, the use of the discounted loss of yield in the future might theoretically be more correct as the determinant of a claim; but for individual cases in the very early phases of stand development it would be extremely difficult to estimate. A claim always leads to loss in profit for the service provider. Individual claims are for different amounts, depending on the size of the unsuccessful regeneration site and the severity of damage to the seedlings forming the stand. The annual value of claims consists of all individual claims received during one year.

Table 2. Alternative criteria for success in stand establishment in this study.

Criteria	Average number of seedlings in stand as a whole	Average number of seedlings in worst 20% by area, at least	Proportion of failed stands in data
1	1500	1000	0.198
2	1500	500	0.132
3	1300	1000	0.090
4	1300	500	0.085

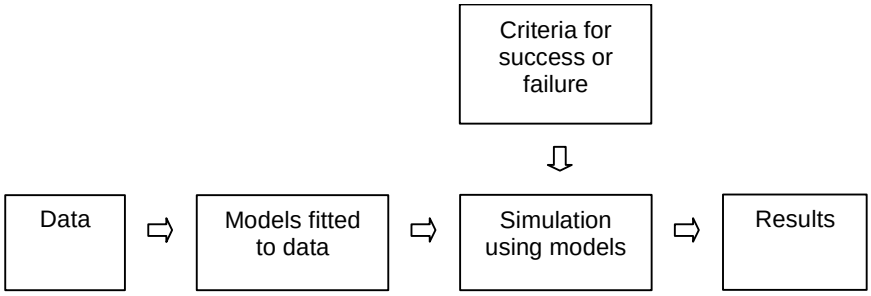

Figure 8. The principle of simulation applied in this study.

The fluctuation in the total amount of periodical claims was studied here by using the Monte Carlo simulation in the modelled business process of a virtual silvicultural service provider. Beard et al. (1977) suggested such an approach for risk calculations with complex distributions. Linear ordinal least squares regression analysis was used to predict the average amount of seedlings needed for failed plantations of different sizes. The variation around the average was modeled by non-linear regression, which set the lower and upper limits for the variation that was supposed to be uniform between the limits. The Monte Carlo simulation process used the regression models and continuous and discrete distributions as input. The annual total of claims was obtained as the output from the simulation model. The simulation was iterated for 160 times for each criterion area combination. A diagram of the simulation model is presented in Figure 8.

The total area of annually established stands in the simulation model varied from 10 to 500 hectares. The total area was divided into individual stands. The sizes of the stands were drawn from a lognormal distribution with parameters $\mu = 0.336$ and $\sigma^2 = 0.375$. The respective values for the mean area of the final-cutting area and the standard deviation of the area of the final-cutting area were 1.7 ha and 1.1 ha. The parameters were taken from a distribution curve fitted to a large unpublished data set on final-cutting areas.

4.3 Results

The annual amounts of the claims for a certain amount of annual planting area were calculated and then divided by the number of planted seedlings. The amount of claims per planted seedling according to each criterion and the expected annual planting area are presented in Table 3. In the case of the lowest criterion (1300/500) the annual planting area had the strongest relative effect on the amount of claims per seedling. In this criterion the probability of failure is fairly low; therefore, with small annual regeneration areas, the amount of claims per seedling remains low.

The probabilities of ruin for different annual planting areas and premiums and criteria were calculated from the simulated results. A clear advantage of scale in regard to risk management was discovered in the study. The risk of ruin is smaller for a large service provider than for a small one when the risk of failure of one stand and the premium per seedling are equal. The curves indicate the risk of the annual amount of claims exceeding

the amount of the premiums collected (Beard et al. 1977). For all criteria it became obvious that 0.01€ was too small a premium, at least for large annual planting areas. For the three lowest criteria, 4 (1300/500), 3 (1300/1000) and 2 (1500/500), as little as 0.02 euros would be enough to cover the annual risk of ruin. For the toughest criterion studied, 1 (1500/1000), not even 0.03 euros was enough to keep the annual risk of ruin under 50%, which is still relatively high (Figure 9).

An adequate premium for the quality guarantee could be 4-8% in addition to all stand establishment costs per planted seedling depending on the scale of the regeneration business of the service provider. The NIPF landowners' average willingness-to-pay for quality- guaranteed forest regeneration was found to be 5% in one survey study (Partanen 2000). The differences between customer segments, however, were high.

Table 3. Average claims per planted seedling from 160 annual simulations (€). The criteria are explained in Table 2 and in the text.

Expected annual	Criteria			
planting area (ha)	1	2	3	4
10.13	0.028	0.016	0.018	0.010
25.31	0.028	0.017	0.019	0.013
50.63	0.031	0.017	0.017	0.013
101.25	0.031	0.017	0.018	0.013
150.19	0.030	0.017	0.018	0.013
200.82	0.031	0.017	0.017	0.014
300.38	0.031	0.018	0.017	0.013
399.94	0.031	0.018	0.018	0.013
499.51	0.031	0.018	0.018	0.013

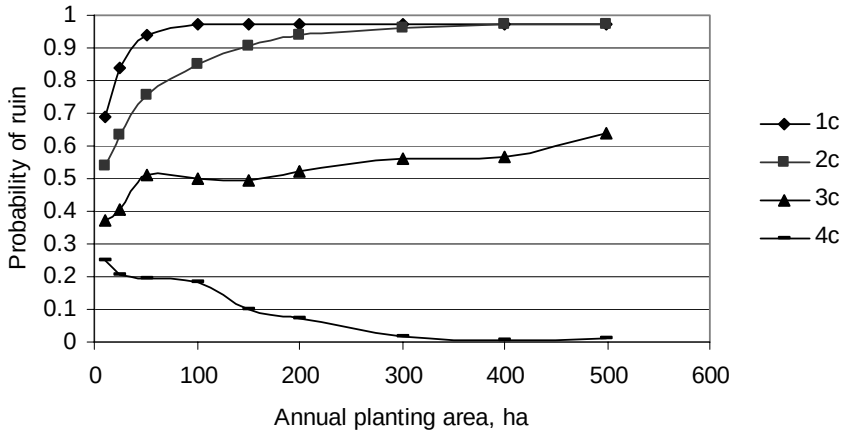

Figure 9. Simulated risk of ruin with the success criterion 1 (1500/1000) as a function of planted area and premiums (c = Euro cent).

5 PREDICTION OF THE NEED FOR EARLY TENDING IN SPRUCE PLANTATIONS

5.1 Background and creation of value

Prediction of the need for early tending is a link between stand establishment and the tending regime of a stand. The purpose is to sort out those recently established stands that most probably require attention and assess the need for early management. The prediction should be based on variables that can be collected during stand establishment and the result should be put into an ICT-based updateable forest management planning system.

A successful classification of stands according to the need for early tending would create customer value by decreasing the process costs due to diminished need for the field inspection of stands. It would also be beneficial in the delivery dimension by enabling correct timing before trees in a secondary position affect the development of the trees forming the main crop. The total costs of the tending regime can also be reduced if early tending is properly done in stands requiring tendings two or more times.

As far as supplier value is concerned, the predicted classification improves cost-efficiency, especially the price-quality ratio of tending, in forest management operations, thus increasing revenues. Prediction of cleaning need could be an after-sales service and a tool for automatic making of an offer for early-tending service. Such an approach would create stronger bonding with the customer and it could be a tool for focusing of marketing. It provides a chance for repeated business if the customer orders tending services after having used the stand-establishment service. The market share of the service provider could increase at the same time, while the share of the service provider in the customer's business increases. The supplier's know-how can be increased if the results of the system are systematically revised.

5.2 Methodology

Learning from data is a method of data mining where algorithms are used to classify, cluster, visualize or by some other means bring information from complex multi-dimensional data structures into a more readily understandable form. Machine learning provides the technical basis of data mining (Witten & Frank 2000). In this study, two methods of supervised machine learning were applied. Supervised learning means that the categories to which cases are to be assigned must have been established beforehand. In other words, it is a question of classification.

The material used in the study comprised a data set from a survey of 3-year-old Norway spruce plantations (Saksa et al. 2002). These data are measurements taken from actual plantations in NIPF forests in Southern Finland. The measurements were carried out by accessing 15 to 20 circular sample plots located systematically in the stands. For every plot, the following variables were recorded: the need for early cleaning, soil texture class, vegetation site type according to Cajander (1909), the number and height of primary and secondary trees. The need for early cleaning was determined as current or predicted need for cleaning during the following three years.

First, the chi-square test was used for testing differences between the prevalence for need of early tending according to site characteristics. Then, two data mining tools, J4.8 and naïve Bayes (NB), were used for creating prediction models to classify individual

stands either as needing or not needing early cleaning. The data were split randomly in half for the construction of classification models. One half was used for testing. The result of classification in the test split was then presented as confusion matrices.

The J4.8 system is based on the C4.5 classification tool consisting of several programs for data mining developed by Quinlan (1993). Witten and Frank (2000) developed Quinlan's programs further and programmed them using Java, and renamed the tool J4.8. The principle in the algorithm is to construct a decision tree consisting of structures that are either

- leaves, indicating a class, or
- decision nodes specifying some test to be carried out on a single attribute value, with one branch and sub-tree for each possible outcome of the test (Quinlan 1993).

The construction of the decision tree by C4.5 (and J4.8) is based on the minimization of the following entropy function:

$$E(n) = \sum_{j=1}^{C} - p_j(C = C_j \mid n) \log_2 p_j(C = C_j \mid n) \qquad (1)$$

where
n = Set of cases
$E(n)$ = Entropy in the set n
C = Class variable
P_j = Probability that a case belongs to class c_j

If all instances belong to the same category, entropy is 0. If the instances are equally mixed, i.e. 1/C of the instances in each class, entropy reaches its maximum at 1.

In the method applied here, the completed tree is pruned afterwards (Witten & Frank 2000). Such a method is called post-pruning or backward pruning. The algorithm of post-pruning used here is based on an operation called sub-tree raising. In the case of sub-tree raising, an internal node can be replaced by the sub-tree of one of its children rather than a leaf (Hall et al. 2003).

Bayesian networks (also called belief networks, causal networks, or causal probabilistic networks) are directed acyclical graphs in which the nodes represent random variables and the arcs represent direct probabilistic dependencies among them (Pearl 1988). One of the simplest forms of a Bayesian network is the naïve Bayes model (Figure 10), where one variable determines the class of the case (C), and the other variables are attributes of the data case (X_k).

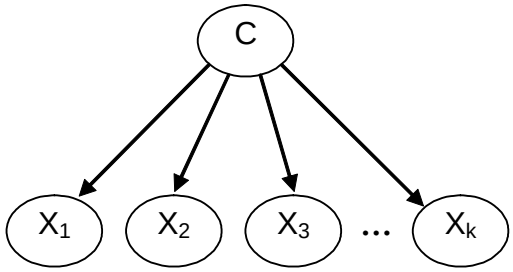

Figure 10. The principle of naïve Bayes.

In this case, the class variable was the observed need for early tending. The NB model assumes that given a class $C=j$, the attributes X_k are independent (Hastie et al. 2001):

$$f_j(X) = \prod_{k=1}^{p} f_{jk}(X_k) \qquad (2)$$

In general, this assumption is not true. In the data used in this study, for example, the soil texture and method of soil preparation are strongly dependent on each other. Although the individual estimates of class density may be biased, the bias still might not affect posterior probabilities as much (Hastie et al. 2001).

In the machine learning of the NB structure, the classifier learns the conditional probability of each attribute X_k given the label C in the training data. Classification is then implemented by applying the Bayes rule to compute the probability of C given the particular instantiation of $X_1, \ldots, X_k$ (Friedman & Goldszmidt 1996). The learner estimates the required probabilities by calculating the corresponding frequencies observed in the training set.

5.3 Results

In the data, the proportion of stands classified as needing early tending was 59% (III). Although there were evident differences in the effect of soil properties on the need for early tending, and even statistically significant according to the chi-square test carried out, classification of individual stands according to their need for early tending was not successful. The accuracy of both methods of classification used in this study was poor. The results showed that there are some site variables that can be used for aiming the checking efforts for young stands to determine the need for early tending. Prediction of the need for early tending in a certain stand, however, did not succeed. Some states of the attributes resulted in learned classifiers different to those expected. For example, the plantations established on mounded soil were often related to the need for early tending, although this markedly differs from current practical experience (Harstela 2004). This may be caused most by biased data. The mounded areas were mostly sites where drainage was seen as

being necessary and the soil was prepared by ditch-mounding. Data consisting of spruce plantations also on drier mounded sites should be used, when such become available.

In conclusion, although some attributes influence the need for early tending in a young Norway spruce plantation, the experience is that in a large set of survey data these influences become thoroughly mixed up. The aim in regeneration of Norway spruce must be to achieve a good regeneration result and at the same time be prepared for early tending. To detect the need for early tending, a survey of young stands should be carried out a few years after stand establishment. The stand-establishment service provider could offer such a survey for customers as a form of after-sales marketing.

6 TIMING OF TENDING AND ITS EFFECT ON THE CONSUMPTION OF WORKING TIME

6.1 Background and creation of value

The effect of stand characteristics on the consumption of working time in cleaning operations basically depends on the number and stump diameter of the removed trees (Hämäläinen & Kaila 1983). It is obvious that the consumption tending time per stand increases with time. The number of trees in secondary positions quickly increases after soil preparation and other stand establishment operations. Later on, most of the increase in the consumption of working time is caused by the increase in the stump diameter of the trees. Competition may even cause death of some trees. The actual intensity of these phenomena in real stands is not very well known. Knowledge of the effect of timing on the consumption of working time, combined with the already better known silvicultural quality effects of stand-stocking spacing, provide better means for planning efficient tending regimes.

Optimized timing in tending reduces the costs of the operations. Know-how regarding the optimization of timing makes it possible to lower the price of the service to create value through customer benefit. The delivery dimension of the relationship value (Ulaga 2003) can be seen in this service as correct timing.

Optimization of the timing of cleaning mainly improves the cost-effectiveness of cleaning, although the silvicultural result is not affected to any great extent. Thus it increases the service provider’s revenues. Apart from this, optimization of timing is actually not a value-adding service as great as the previously mentioned quality-guaranteed stand establishment service and prediction of need for early tending. Optimization of timing, however, could be integrated into a forest management planning system managed by the service provider, and the offered management planning service could be seen as a value-creating function from the supplier’s standpoint.

6.2 Methodology

Work productivity functions have often been used in calculating time consumption as a function of work difficulty factors (Harstela 1991). In tending operations, the foremost factors affecting the consumption of working time are the diameter of the removed trees and the spacing (number of stems per hectare) of the removed trees (Hämäläinen & Kaila

1983). The variation in stand characteristics between stands and within individual stands is high in young stands. This makes it very difficult to compare the effect of timing on the productivity of tending operations with a small amount of data. In this study, a method was developed to compare different timings of tending from the standpoint of productivity using a relatively small amount of data.

Tree rings have often been analyzed for the purpose of estimating diameter increment in growth and yield studies. Bark models are needed to estimate the thickness of bark for different stump diameters without bark. In this study, the tree ring measurements were used together with bark models for determining the diameters of secondary trees in a stand two years ago. This information was then used for calculating the consumption of working time by using work productivity functions. Thus, it was possible to make a comparison made to determine the effect of delaying tending by two years on the consumption of working time in a certain stand.

The material for this study was collected in a field survey of stands where the subjective estimation of the need for tending was already a bit late compared to the current guidelines for the management of young stands (UPM 2001). Both early and final tending sites were included in the data. The field measurements began with a tree tally on circular sample plots. The dead stems were also recorded. Sample trees were measured more closely and sample discs were cut from them. These discs were stored frozen until the tree-ring data were measured using a microscope. Bark thickness models and diameter increment models were fitted to the data by non-linear regression. After construction of the models, the "state" of the sapling stand two years earlier was calculated using the constructed models. Work productivity functions were then applied to estimate the consumption of working time in the present state and two years earlier in tending the same stand.

6.3 Results

The timing of tending has a powerful impact on the productivity of motor-manual work in tending. Figure 11 shows the increment of the stump-level basal area of the removed trees and the increment of calculated consumption of working time. The lower points and those on the left are the earlier time points of cleaning, while the higher points and those on the right indicate the later time points of cleaning.

There were a number of dead trees in the studied stands, particularly in the four closest-in-spacing final-cleaning stands. The numbers of dead trees in those stands were 6%, 9%, 16% and 19% compared to the number of removed living trees. The stand with the highest increment of consumption of working time was not one of these four.

There was a marked difference between cleaning and no cleaning in the simulated average stand height and stand diameter at 11 m dominant height (Figure 12). There was not much difference between the results of the cleaning treatments (now or 2 years earlier). The simulated diameters were somewhat greater in stands cleaned two years earlier in all of the final-cleaning stands. On average, the breast height diameter at 11m dominant height was 3.7% higher in stands cleaned 2 years earlier than in the stands cleaned now.

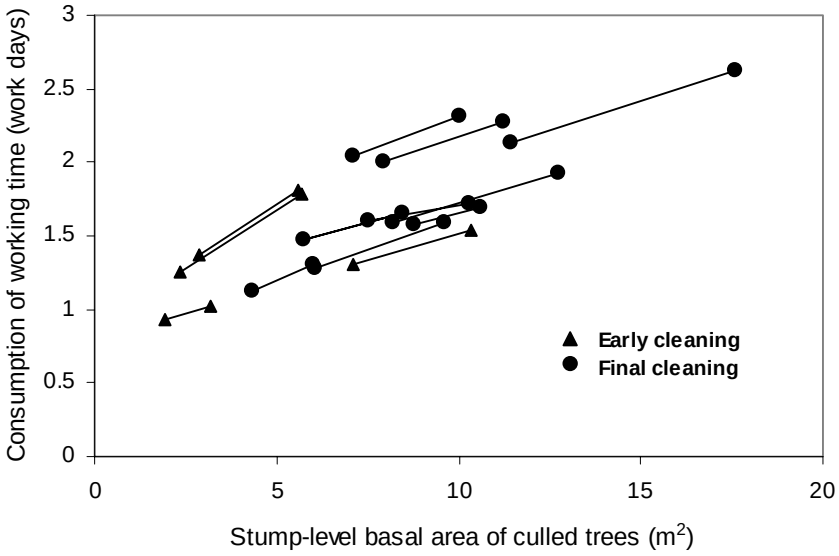

Figure 11. Calculated consumption of working time in the studied stands as a function of the stump-level basal area of the removed stems (IV). The interpolation lines connect the two time points in the same stand.

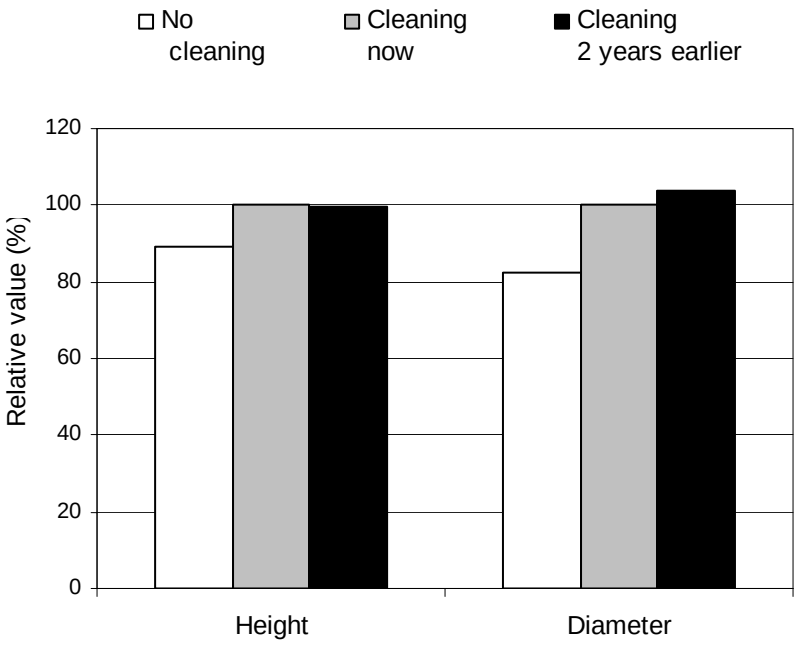

Figure 12. Average height and diameter of spruce at the end of the simulation period (H_{dom} = 11m) by treatment and by stand (IV).

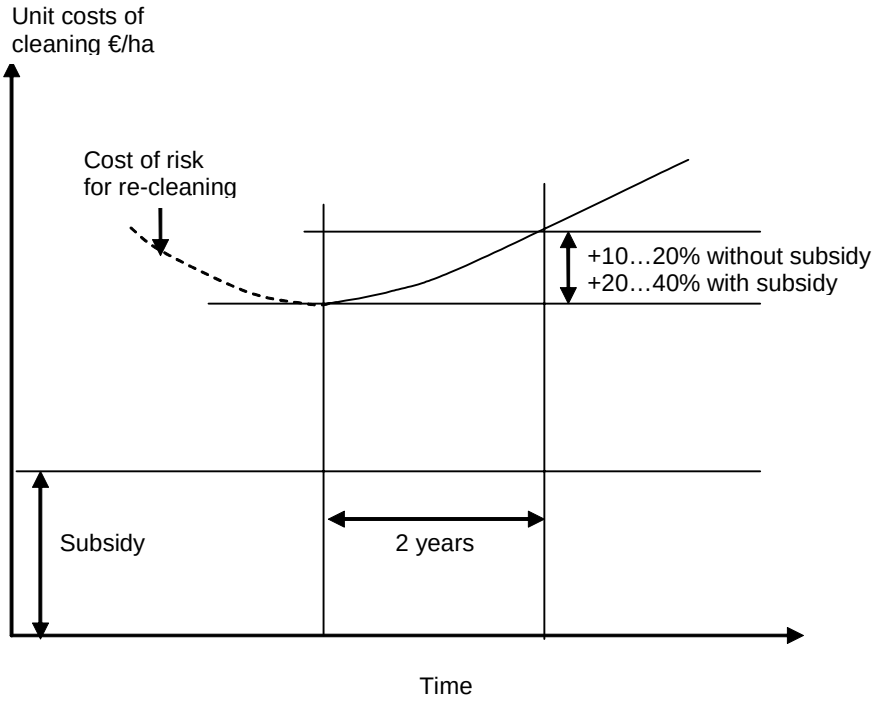

Figure 13. A hypothetical example of cost curve for the effect of government subsidy on the relative increase in cleaning costs from a notional optimum.

The Government's subsidies for tending are based on the area treated in Finland (Laki kestävän… 1996). Therefore, the optimization of timing of tending also highlights the relative profitability of alternative time points of tending (Figure 13).

7 DISCUSSION

A three-step value-creating management concept for the establishment and tending of young stands was created in this study. Norway spruce was used as a case in point, because of the high recent interest shown towards it in stand establishment. The development of the concept covered the management of young stands from establishment until the first commercial thinning. Creation of value for both the customer and the supplier was the key issue when launching the study. The scenario study presented acted as an initiative for the outlined service model. Research needs arising from the scenario study were converted into a more detailed research plan including the three steps of the created management concept.

The first step, quality-guaranteed stand establishment, turned out to be suitable for further development. The calculated profitable premiums mostly fit into the willingness-to-pay frames from the study by Partanen (2000). That study, however, was based on a survey study and WTP was not tested in practice. Unfortunately, no other studies have been

reported on that topic. In addition, the total costs of management of the service process were not fully taken into account here. The ??present?? study totally covered the costs of the risks, however.

Blennow and Sallnäs (2002) found that among different risks, NIPF landowners were most willing to invest capital on preventing threats to young stands and on resisting the fall of stumpage prices. In their study, other risks of private forestry had less importance. The risk of failure in stand establishment and the task of inspecting early stand development were transferred to the service provider in this study. Especially for NIPF landowners not living close to their forest property, this service concept could provide marked advantages in forest regeneration. For a long time already, wood sales to forest-industry companies by NIPF landowners has been done through letters of attorney given to FOAs . This approach should also be possible in wood production. Taking into account all the costs of wood production, it could be considerably more profitable to avoid process costs such as travelling to the forest holding and inspection of young stands. The service supplier can optimize operations by carrying out these tasks on a larger scale. Taking care of recently regenerated stands is most important on fertile sites where weeds are the foremost risk to seedling development. Service providers located in geographical areas which include an abundance of fertile sites are most likely to adopt the quality-guaranteed service concept.

The linking element between stand establishment and cleaning, i.e. prediction of the need for early cleaning, did not succeed with the data and the data-mining tool used. It seemed that the rapid emergence of secondary trees in harmful numbers can not be reliably predicted in a certain stand by means of stand characteristics. Therefore, a survey of recently established stands is justified also from the standpoint of planning a tending regime. The data used for this study, however, did not yet contain many mounded stands established on dry sites, where mounding results in a smaller number of emerging secondary trees than is the case following disc-trenching (Harstela 2003). As new data are gathered in the project dedicated to quality management of forest regeneration, the same classification trial should be repeated.

The third step of the created management concept, improvement of cost-efficiency of tending, showed great development potential in the cost-efficiency of tending. The cost-efficiency of operations is useful especially in the case of planted Norway spruce stands, where the quality of wood cannot be influenced very much by altering the initial spacing of the stand (Johansson 1997, Harstela 2003). In the case of a large-scale provider of silvicultural services, the management of operations plays a key role in the endeavor to get full resource-saving potential out of the optimization of timing. ICT applications have successfully been utilized in achieving marked savings in supervision (Åkerman 2001).

The data sets used in the empirical calculations were rather small. In Articles II and III they represent the operational scale of a typical service provider during one year. In Article III, the data set was small, but it had been collected within a larger geographical area. Therefore, the results cannot be regarded as being comprehensive enough for practical application as such. The role of this study is typical of applied research, which creates bases for application, not ready-to-use solutions. The development work required to turn the research results into final service solutions must be done by practitioners (Kalela 2002).

The theories on creation of value in business relationship used in this study were made for rather different business environments when compared to non-industrial private forestry. Despite the different operational environment, the basic ideas appear to be applicable here, too. Supplier value in the outlined service concept relates to many dimensions of creation value in Vandermerve (1993). The offered services make it possible

to create a stronger bonding with the customer, this hopefully leading to repeated business and helping to gain a larger share of the market. Also the share of the supplier's business with respect to the customers can be increased. Especially quality-guaranteed stand establishment service increases the level of know-how of the service provider, which leads to higher revenues through better cost-efficiency of operations.

In the service concept outlined above, the bonding between the customer and the service provider was made by means of marketing, not by compulsory forest management fees, as is the case today. Earlier, the almost monopolistic market position of a group of large services providers did not stimulate service development through competition. Finland's compulsory forest management fee may have decelerated the development of new services for NIPF landowners (Kolström & Harstela 2005). Supplier performance in silvicultural service has, therefore, hardly had a significant impact on average customer loyalty in regard to silvicultural services.

The change from almost monopolistic silvicultural service markets to freer markets with several service providers has been a gradual one. There are still some obstacles to competition on the markets for silvicultural services for NIPF landowners. Harstela et al. (2001) has named the most important of these as being the following:

- Forest management fees set by legislation are aimed to only one type of service provider (FOAs)
- Subsidized public organizations still provide production services
- Membership of an FOA is fixed to a geographical area
- Traditions
- Restrictions on the availability of forest stand data gathered by public organizations only to one service provider

If these obstacles are mitigated in the future, the competition among different silvicultural service providers business can be expected lead to the development of new approaches to service provision. Entrepreneurship, especially, has been seen as a key issue for the development of service innovations in several fields of business (Tamura 2005).

In Finland, one problem facing this particular business field may be seen in the small size of the individual service provider's enterprises, and this could make it difficult to find the resources for R&D. This thesis is partly the result of a project conducted with the purpose of analyzing practical service provision regarding its most knowledge-intensive elements. One approach (II) implemented with the emphasis on forest owners, who want comprehensive service with guaranteed results. If the results are applied in practical business, every service provider has to consider which customers to focus on with such a service concept. A recent survey revealed that there are customer segments very interested in such a service, but also that there are customers that were are interested (Harstela et al. 2005). Other approaches (III, IV) aimed for better operational efficiency, which could benefit everyone utilizing the results. These do not necessary require any special service approach, only good information systems.

From the customer perspective, most of Ulaga's (2003) dimensions driving relationship value can be found in forest management services. Not all of them were included in this study, although most of them formed the basis from the customer standpoint for the outlined service concept. Both sacrifice dimensions, direct product costs and process costs, were evident in the created service concept. Service support, supplier know-how, and delivery were the most important benefit dimensions.

This study concentrates mainly on the utilitarian values in service marketing. In addition, there are hedonic values that may provide competitive advantage in service

marketing. Babin and Attaway (2000) studied atmospheric effect as a tool for creating value and gaining the appropriate market shares. Their results suggest that the retail atmosphere can be a useful tool in building customer behavior. Especially penetration into the markets of silvicultural services as a new service provider or gaining a market share as an old service provider can be achieved by providing hedonic elements in service marketing. Personal contacts are important in the provision of silvicultural services for NIPF landowners (Kettunen & Kärki 2004). Ulaga's (2003) approach was to include social benefits as one component of consumer utility creating relationship value.

A comprehensive service concept in different forestry operations can be the first step towards a more comprehensive forest property management service. Vandermerwe (1993) described the development of a typical relationship between a service provider and a customer; in it, the relationship between the supplier and the customer becomes closer, this simultaneously reducing the costs of maintaining the relationship. An updateable forest management plan, which also includes the accurate timing proposals of silvicultural works, could be one usable tool for promoting such a development in silvicultural services. It could create a good opportunity for the planning of operations and their timing to achieve cost advantages. The principles of modern selling-value thinking (e.g. Kaario et al.2003) may be good tools for assessing the main aim of the business branch. Close co-operation between service provider and customer can create marked advantages in cost-effectiveness and quality. Although the core operations of the services may look like a black box to the customer, key background information has to be provided (Dawson 2000). Such information should explain the preferences among the different alternative approaches to the current situation.

Hänninen et al. (2001) found that NIPF landowners living outside their forest properties had poorer quality of stand establishment and early management of the established stands than did the farmer-forest owners. According to Niskanen (2003), few forest owners are aware of the current need for tending in their young stands. Not even a valid forest management plan had any effect on the timing of tending. The amount of tending, however, was affected by the forest management plan. Bringing production economic aspects into the planning of silvicultural service provision will most likely bring with it cost advantages and quality improvements even with relatively small inputs. The tools studied in the present study were rather technological by nature. Also, the quality-guarantee service principle was quite inflexible compared to the concept of service-guarantee strength introduced by Hays and Hill (2005). An R&D approach to silvicultural service provision and marketing, even more promising, could be had from the standpoint of marketing psychology focusing on the personal interaction dimension of Ulaga's (2003) model.

There has been substantial variation in the quality of forest regeneration results between different service providers (Saksa et al. 2005). Quality and proper implementation are nationally important for the whole forest sector in Finland (Reunala et al.1999). If the service concept created in this study were to attract the interest of NIPF landowners, it would also be very expedient for the implementation of Government's forest policy to create premises for the creation of deeper customer relationships in the field of silvicultural services.

8 CONCLUSIONS

A large array of data gathered from silvicultural operations and quality assurance surveys could be used in the development of new, more knowledge-intensive types of services, for silviculture. Effective use of such services usually require ICT applications for the management of stand and operational information. The created concept for quality-guaranteed establishment and tending of Norway spruce stands appeared to be practicable, although there was a major drawback in the prediction of need for early tending. It emphasizes the importance of quality-assurance surveys in recently established stands also from the standpoint of operational planning for tending. In order to improve the management of young stands, better knowledge is still required of the competition dynamics between main and secondary trees in different tending regimes. Individual development work needs to be done for each service provider in order to convert the research results into a practical service process.

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