The Triad Perspective on Business Models for Wood Harvesting

Tailoring for Service Satisfaction within Forest Owners Associations

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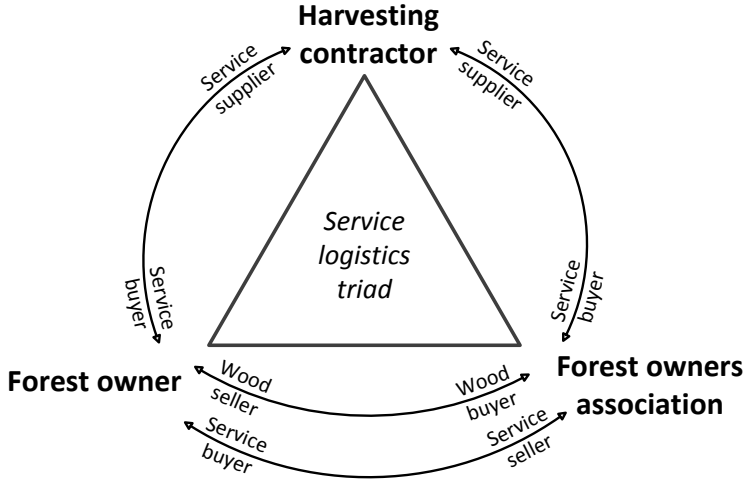

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Abstract

Swedish forest companies have outsourced their harvesting operations extensively to contractors. The role of these professionals is increasingly important for wood supply, especially for companies purchasing most of their wood from non-industrial private forest owners, for which harvesting is normally arranged by the company. Contractors are key actors in maintaining owners' willingness to sell wood, which has become more challenging and requires attractive service offers. As forest owners associations (FOAs) are owned by their members, they have a large responsibility to offer services satisfying owners' goals, but at the same time they need to satisfy industrial demands.

This thesis applies a triad perspective on harvesting services to assess varying needs and value perceptions for FOAs, contractors, and forest owners. The objective is to investigate the possibilities and needs for FOAs to tailor their business models to increase the total success of service triads.

Two FOAs with fully outsourced harvesting services were investigated, and research was conducted as two parts. The first part (Paper I) used process mapping to analyze the impact of industrial context on business activities for harvesting. The results revealed both differences in demand uncertainties and different needs for production adjustments due to varying supply responsibilities (own mills *vs*. no own mills). This caused different needs for capacity flexibility, preferably met by corresponding proportions of short–term contracts. Many managers, however, perceived a shortage of contractors and instead used large proportions (>90%) of long-term contracts and satisfied flexibility needs by requesting the use of less specialized machinery. The second part (Paper II, III) used interviews, surveys and follow-up data to identify and analyze success factors satisfying each group of the triad. Especially large variations were found among forest owners in assigned service values and performance perceptions. Furthermore, results revealed strong discrepancies between currently applied follow-up parameters *vs*. parameters that respondents actually valued most. Specifically, parameters most important for contractors' satisfaction were different from parameters important for their profitability.

The thesis concludes with a characterization of the tailoring needs for different industrial and local contexts, and also describes general needs and responsibilities for each of the three perspectives concerning service development.

Keywords: contractor, production management, wood procurement, NIPF owners, logging

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Dedication

Till Birgit Olsson.

Ingen minns en fegis.
Okänt ursprung

Contents

List of Publications

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

I Erlandsson, E. (2013). The impact of industrial context on procurement, management and development of harvesting services: a comparison of two Swedish forest owners associations. *Forests* 4(4), 1171-1198.

II Erlandsson, E., Fjeld, D. & Lidestav, G. Measuring quality perception and satisfaction for wood harvesting services with a triad perspective. Accepted for publication in *International Journal of Forest Engineering*. DOI: 10.1080/14942119.2017.1257304.

III Erlandsson, E. Success factors in the business relationships of harvesting contractors within Swedish forest owners associations (submitted manuscript).

The contribution of Emanuel Erlandsson to the papers included in this thesis was as follows:

I Initiated and planned the study, conducted all interviews and transcriptions, performed the analyses and process mappings, and wrote the manuscript with counselling from the supervisors Dag Fjeld and Gun Lidestav.

II Initiated the study and planned it together with the supervisor Gun Lidestav, conducted all interviews, designed and distributed the questionnaires, performed the calculations and statistical analyses, analyzed the results together with the supervisor Dag Fjeld, and wrote the manuscript with counselling from both supervisors.

III Initiated and planned the study, collected all data, performed the statistical analyses (with counselling), analyzed the results, and wrote the manuscript with counselling from the supervisor Urban Bergsten.

1 Introduction

1.1 Harvesting contractors in Sweden: current status

Wood harvesting in Sweden is big business. Ager (2014) recently estimated that professional contractors conduct 75-80% of the harvesting operations from stump to roadside. The annual national harvesting volume of more than 70 million solid m^3, when combined with an average harvesting cost of approximately 110-120 SEK per unit (Swedish Forest Agency, 2014), thus translates to a total value of annually purchased contractor services that exceeds 6 billion SEK (roughly 600 million Euro). Operations are highly mechanized, and the Swedish forestry conditions and industrial structures are homogenous enough to enable the use of a single type of harvesting system using cut-to-length (CTL) technology, which consists of a single-grip harvester and forwarder. A typical contractor owns and manages either one or two of these machine units, and has less than nine employees (Häggström et al., 2012). Harvesting operations comprise both final felling (approximately 75% of annual harvesting volumes; Swedish Forest Agency, 2014) and thinning (25%), and contractors commonly optimize their machinery to be better suited for one of these operations. The purchase costs of conventional machinery for large-scale forest operations range from approximately 5-6 million SEK (500-600 thousand Euro) for a small-sized unit (harvester and forwarder) specialized for thinning operations, to up to 7.5-8.5 million SEK (750-800 thousand Euros) for one of the largest units specialized for final felling[1]. In addition to these costs of machinery, contractors face costs of necessary equipment, such as cars and working trailers, along with insurance costs and maintenance agreements, among others. Consequently, the capital input required to start-up and run a professional system of today's standards is massive.

[1] These cost approximations are based on the experience the author has gained during six years of research and teaching in the field of contractor forestry.

The Swedish forest industry operates in a highly competitive international market. Of the total production cost for roundwood, harvesting costs constitute the largest share (Brunberg, 2012). Not surprisingly, harvesting has been a major focus for productivity improvements and cost reductions throughout recent decades. The need to cut costs and reduce financial risks led to extensive outsourcing of harvesting services during mainly the 1990s, partly due to pressure from the economic crisis that was affecting Sweden at that time (Eriksson 2016). The development towards large-scale outsourcing of mechanized harvesting had however started already in the 1980s (Kardell, 2004), and in the southern parts of Sweden contractors were dominating already by then (Lidén, 1987). Outsourcing did not only reduce forest companies' needs for the bounded capital required to invest into expensive machinery, but also gave a desired boost for productivity developments and price reductions, with competition between contractors as the driving force (Norin, 2002). Simply, a contractor who is able to perform the work at the lowest price level while fulfilling all service requirements is most likely to establish and maintain a contract, which is commonly agreed for an annual harvesting volume from final felling and/or thinning with payment through piecework rates (Norin & Furness-Lindén, 2008). Commonly, standard long-term contracts can be terminated on 6 month horizons (www.apse.se), while the investment cycles for machinery last several years (Vestling, 2012). Thus, when compared to ownership, outsourcing has enabled better adjustment of harvesting capacity to meet current company needs (Ager, 2014). Consequently, most of the investment risks of capital-intense machinery today are carried by contractors. If a company wants to retain a low price level that still ensures profitability for contractors, then they must offer work conditions that utilize the capacity of machinery to a high degree (Mäkinen, 1997) and carry out sufficient preparatory planning for its efficient use (Greene et al., 2004; Spinelli, 2008; Norin & Furness-Lindén, 2008).

Since 2003, the long-lasting trend of increased harvesting productivity in Sweden has stagnated and even begun to decline (Nordfjell et al., 2010; Eriksson, 2016). There seem to be no clear physical or contextual reasons that explain the declining curve, but there are indications of managerial causes (Eriksson, 2016). This finding has come at a time when contractor profitability (Hultåker, 2006) and the overall attractiveness of the machine operator profession (Bergqvist, 2009) have decreased The latter has been especially relevant for the education of operators, reflected in educational institutions repeatedly failing to attract the number of students required to meet the sector's need (Lindberg, 2012); this is, at least partly, due to the sector's reputation as being stressful and offering lower salaries than other machine operating businesses (Bergqvist, 2009). Similar findings have also been reported from

Finland (Penttinen et al., 2011). Furthermore, there are reports of fading numbers of competent contractors in parts of Sweden (Furness-Lindén, 2008). To fulfill all of the service requirements, which today include demands for quality and precision (Högnäs, 2000; Eriksson et al., 2015), as well as social and environmental aspects (Hultåker, 2006), a contractor must have extensive qualifications. Hence, there is not only a need for improved management practices, but efforts must also be made to increase the attractiveness (including profitability) of the profession and to secure a long-term supply of competent operators and contractors.

1.2 Harvesting services in the context of FOAs

Along with the problems outlined above, it has been increasingly challenging for the forest industry to purchase wood from non-industrial private forest (NIPF) owners (Mattila & Roos, 2014), who often assign higher values to the other benefits of forest ownership than to incomes from harvesting (e.g. recreational activities) and often are not resident on their properties (Berlin, 2006). However, many Swedish forest companies largely rely on NIPF owners, and thus, their willingness to conduct harvesting operations in their forests, for their supplies of wood. The harvesting of purchased wood is usually arranged by the companies themselves, and the operations are generally performed by contractors. Thus, NIPF owners are not only suppliers of wood, but also buyers of harvesting services, which consequently need to be increasingly attractive to interest the owners. Modern Swedish NIPF owners typically have a low dependence on forestry incomes and there is large variation in their forest ownership goals. Both of these characteristics have raised the need for forest companies to offer new and more attractive services that aim to increase NIPF owners' willingness to sell wood (Mattila & Roos, 2014). Similar trends and challenges for the wood supply of forest industries have been noted in many other developed countries (Häyrinen et al., 2015). Customer satisfaction among forest owners is essential for establishing and maintaining loyal suppliers, which is important for maintaining stable wood supply (Staal Wästerlund & Kronholm, 2016). In this respect, contractors play a crucial role as service suppliers, and their performances and abilities to satisfy forest owner expectations are undoubtedly key factors in the competiveness of their service-buying forest companies.

Approximately 100,000 of Sweden's NIPF owners are organized in forest owners associations (FOAs), and together they own 6,1 million hectares (27%) of the country's productive forest land (Swedish Forest Agency, 2014). For FOAs, long-term relationships with deeply loyal members and other suppliers

have been a cornerstone of the traditional business models they have applied (Staal Wästerlund & Kronholm, 2016). Similar to other forest companies, FOAs operate in open markets and must by law (the Swedish Competition Act) allow their members to sell wood to any other buyer; however, as a cooperative, an FOA on the other hand cannot refuse deliveries from one of its members (Lidestav & Arvidsson, 2012). Currently, Swedish FOAs struggle to maintain loyalty and commitment among forest owners (Kronholm, 2015), partly due to their failures in adapting offered services to the needs of today's forest owners (Mattila et al., 2013; Mattila & Roos, 2014; Staal Wästerlund & Kronholm, 2016).

In the FOAs' case, wood purchase is the basis for their existence. Forest owner cooperatives arose in many parts of Sweden during the 1920th and 30th (Gummesson, 1993; Norra Skogsägarna, 2008), and initially their purpose was to increase knowledge of forestry. Once the organizations grew, they were able to use the bargaining power of the large collective (through FOA representatives), and thereby increase the value of members' wood deliveries to the powerful wood industries at that time (Gummesson, 1993). Soon, the FOAs role expanded with employed foresters mainly giving counselling but also organizing operations for members unable to do the work on their own (Norra Skogsägarna, 2008). As they grew stronger, many FOAs founded their own processing industry. Thereby they could both uphold the demand for members' wood and keep for themselves the profits involved with refinement (Kardell, 2004; Karlsson, 2006; Norra Skogsägarna, 2008). The once many and local FOAs have by time merged into larger, regional organizations.

In addition to this development, self-employment in harvesting operations has continuously decreased among Swedish NIPF owners during the last century. Already in the 1960s figures for north Sweden show a drastic reduction in the proportion of delivery wood, which is wood harvested by NIPF owners themselves or by their own arrangement, to approximately 60%. This decrease had resulted in the employment of own forest workers and ownership of machinery (Norra Skogsägarna, 2008). In the 1990s corresponding figures were only about 30% in the same part of the country, and the FOAs had evolved into full-service companies offering forestry services to both members and other NIPF owners. Like other forest companies, and for the same reasons as mentioned before, FOAs had by then also outsourced most of their harvesting services to contractors. Recent estimates show a current level of 8% self-performed harvesting on the national level (Swedish Forest Agency, 2014). The proportion of delivery wood is higher for the southern part of the country, at least for an FOA (18%; Södra Skogsägarna, 2016), while for northern Sweden, levels of 8% or less were reached already 10 years ago (Norra Skogsägarna, 2008).

The modern FOAs are still organizations owned and governed by their members, and they do not only increase the value of members' wood deliveries by *trading* large volumes on mainly the national market, but also in many cases do *processing* and sales of wood-based products on the international market. Today's employed FOA representatives are mainly guided by economic goals and/or industry demands for wood supply, and thus must support goals that risk to conflict with the sometimes non-economic objectives of their members (NIPF owners) (Berlin, 2006; Lidestav & Arvidsson, 2012). For this reason, the FOAs have strong incentives and responsibilities to develop and adapt services that will better meet the increasing variety of goals among their present and expected future members (Kronholm, 2016), and simultaneously satisfy their own business goals. This type of development is also important for attracting new member categories whose ownership goals are not congruent to the FOA business goals (Berlin, 2006). As an effect of this development, both the need and the importance of contractors have increased among FOAs. Thus, they largely depend on close collaboration with their contractors for service development and deployment, and the presented trends indicate an even further growing importance.

Similar three-party business relationships as the one described (between the FOA, the contractor and the forest owner) are commonly referred to as *service logistics triads* within the field of third-party logistics (Bask, 2001; Selviaridis & Spring, 2007; Daugherty, 2011). To fully describe the success of a logistics collaboration (for harvesting services in this case), it is best to employ a triad perspective, which forms a holistic perspective from all three individual service perspectives, rather than merely describing dyad relationships (Bask, 2001). Development efforts should focus on understanding how service performances influence other actors within the supply chain, for example, customers at various levels (Hertz & Alfredsson, 2003). The research underlying this thesis applied a triad perspective not only to analyze service values and performances within harvesting service triads, but also to understand relationship contexts and the dependencies between parties. An important aspect is the bi-directional customer relationship between forest owners and FOAs (Figure 1), and in this thesis the forest owners are mainly considered to be customers of a service. The research covered in this thesis has also considered the close relationship between service purchases and wood sales.

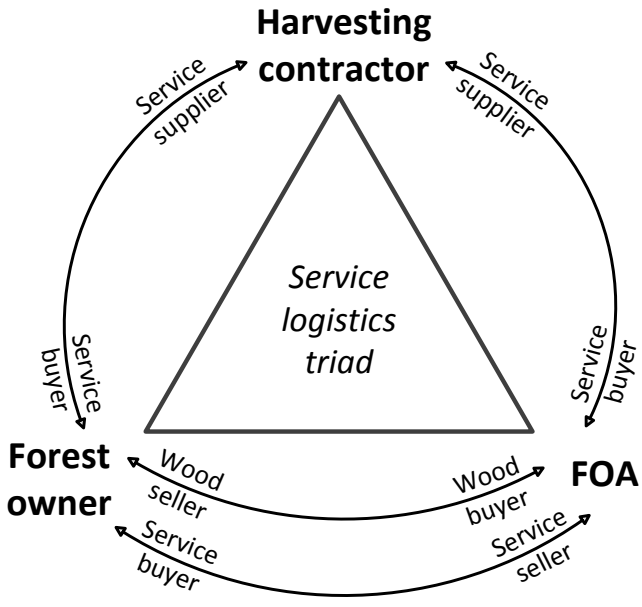

Figure 1. The logistics triad view of harvesting service relationships applied in the studies of FOAs within this thesis (author's illustration).

1.3 Objectives

The objective of the research presented in this thesis was to explore the varying needs and quality perceptions of harvesting services from the perspectives of FOAs, contractors, and forest owners. The presented research also assessed how the interests of different groups are balanced, with a focus on the possibilities and demands for FOAs to develop tailored business models that will increase the total success of service triads.

All of the presented studies were conducted at the two FOAs Mellanskog and Norrskog, which together represent 43% (2.7 million hectares) of the productive forest land connected to Swedish FOAs (Swedish Forest Agency, 2014). Both of the FOAs have fully outsourced their harvesting services, but are contextually different in respect to their supply responsibilities. One association does not own mills and is only involved in wood trade, while the other FOA supplies its own sawmills and trades mainly pulpwood.

Three studies (Papers I-III) were performed at these two FOAs, with the following specific objectives:

The first study (Paper I) aimed to identify and describe the impacts of different industrial contexts on procurement, management and development of harvesting services within the two studied FOAs. *Procurement* in this respect

refers to the obtaining or buying of harvesting services, including preparatory planning, negotiation and contracting. *Management* refers to the organization, coordination and supervision of harvesting activities to achieve defined business goals. *Development* refers to systematic improvements in business activities that involve harvesting services.

The objective of the second study (Paper II) was to explore perceptions of quality from the perspectives of the FOA, the contractor and the forest owner, and analyze their satisfaction with performed services. For this purpose, the study developed and tested a tool for measuring quality perceptions of harvesting services, which also enabled the positioning of service relationship success from a triad perspective. Perceptions of the FOA were based on responses from production managers, who are responsible for relations with contractors.

The main objective of the last study (Paper III) was to identify and rank key factors associated with contractor success in terms of their satisfaction with working conditions and profitability, as well as the ability to meet the needs of customers both upstream and downstream in the wood supply chain (forest owners *vs*. FOA managers). The study also included a wider factor analysis to identify what potential impact contextual factors have on factor performances. An additional objective was to compare how the performance indicators that are currently applied by FOAs' match those identified in the study.

2 Materials and methods

2.1 Methodological approaches and data collection

The research underlying this thesis was conducted as two separate parts, with the first part resulting in Paper I and the second resulting in Papers II and III. The first part (I) employed a *system perspective* to understand how processes for harvesting services at the FOAs were restrained by different wood supply situations, and to what extent this affected the need for harvesting services and their management. A qualitative approach was used for this part's single, but extensive study. The second part (II and III) used a mixed methods approach, utilizing both qualitative and quantitative methods to study business relationships from a *triad perspective*, which helped explain how various interests are balanced in harvesting service triads.

Interviews constituted the most important data source for both parts of the research, and further data collection and analyses were based on these initial interviews. Respondents were sampled in sufficient numbers and with purposeful sampling structures to ensure a representative sample that captures large variability. Both parts of the research began by contacting central staff managers, who then assisted in contacting respondents with the knowledge and experience required to answer the questions. Further respondents were then continuously selected based on recommendations from previous respondents, a practice which reflects the snowball sampling technique (Robins Sadler et al., 2010). The questionnaires and data compilations used during the quantitative studies were based on the outcome from interviews. The extensive data material collected and analyzed during the research underlying this thesis is presented in Table 1. A summary of each study's design and analyses is presented in the following text.

Table 1. *A summary of the data collections, as well as the resulting materials used for analyses*

	Data collection	Sample	No. of respondents	Resulting material
Part 1 (I)	Personal interviews *(Feb-Aug 2011)*	Central staff managers	4	Ca. 30 hours of recordings + notes, 197 A4-pages of transcribed text
		Production managers	6	
		Contractors	6	
Part 2 (II) (III)	Telephone interviews *(Jan-Feb 2014)*	Industry representatives	2	Ca. 14½ hours of recordings + notes, 3 per-group lists of perceived service values
		Production technician	1	
		Production managers	2	
		Contractors	8	
		Forest owners	8	
	Extraction of follow-up data *(Mar-Sep 2014)*	Central staff managers (providing raw data and counselling)	6	Excel databases of processed data for contextual factors, operational performance, service satisfaction, and contractor profitability; all concerning the year 2013.
	Questionnaires *(Dec 2014-Feb 2015)*	Contractors	30 (answered)	
		Production managers	17 (39 obs.)	
		Forest owners	168 (answered)	
	Compilation of financial data *(Apr 2016)*	Contractors	30 obs.	

2.2 The system perspective: mapping context and processes (I)

In the first study a structure that enabled the comparison of various industrial contexts was developed, as well as the description of their consequences for operations management and the varying needs both between and within the two case FOAs. The methodology chosen was process mapping, or more specifically function modeling (described below), and the data collection was designed specifically for this purpose. For the interviews, variability among respondents of operating contexts and management was considered necessary to identify differences. Therefore, respondents were selected from both central management positions and different locations (one-third of all FOA wood supply districts, six of eighteen at the time of the study). Geographical variation was ensured by sampling from two districts at three equally large organizational units of the studied FOAs; the whole FOA in one case, and two regions at the other, larger FOA. At each of the six selected districts, one production manager, who is the FOA representative responsible for planning his/her district's harvesting operations and fulfilling delivery plans to satisfy mill demands, was initially interviewed. One contractor per district was also interviewed, thus providing *two perspectives* on district management routines to better understand the

relationship between the two parties. Together, the selected respondents gave complete coverage of all the hierarchical levels within the FOAs' harvesting functions. All interviews were conducted individually and face-to-face in a semi-structured manner that followed three distinct themes: (i) business goals and directives; (ii) management, information exchange and follow-up; and (iii) constraints, variations and problems. For interviews with managers, *stimuli material* consisting of a formal structure was prepared to aid the hierarchical structuring of decisions and processes (Table 2) from FOA strategy down to short-term operations management. The structure was based on the generic framework for supply strategies developed by Nollet et al. (2005).

Table 2. *The structure used for interview discussions. Based on Nollet et al. (2005)*

Firm strategy	Supply strategies		Functions in focus for the interview
	Perspective	Processes & decisions	
Business goals	*Strategic perspective*	*To be discussed*	Order/Purchase/Production
What? Why?	Long-term horizon		
Organization	*Tactical perspective*	*To be discussed*	Order/Purchase/Harvesting
How to?	Medium-term horizon		
Implementation	*Operational perspective*	*To be discussed*	Purchase/Harvesting
Doing it	Short-term horizon		

All the interviews were recorded, and their manual transcription was also considered necessary to enable comparisons between respondents and the continuous validation of constructed process maps. The transcription solely focused on the *content* of respondents' answers and, as such, did not require precise word-by-word transliteration. The process of transcribing has been identified to facilitate interpretive thinking (Lapadat & Lindsay, 1999), and thus comments and comparative notes were simultaneously written next to the transcribed text and any mentioned decisions or activities were highlighted as a pre-step to the subsequent analysis.

Function modeling was chosen from the other available techniques for process mapping (cf. Aguilar-Savén, 2004) because of its promising potential and previous successful application in forest industry-related studies (Cascini et al., 2008; Haapaniemi, 2011). Respondents described a hierarchy of parallel on-going activities, and a method was preferred that describes processes as *individually operating functions* rather than sequences of activities where the initiation of a following process is directly dependent on the completion of the preceding process. A structure that enabled the direct comparison of the two FOAs in order to identify and analyze differences was also needed. The Integration Definition for Function Modeling 0 standard (IDEF0) (NIST, 1993)

met these requirements, as it offers detailed rules and techniques for the consistent modelling of functions with their hierarchies and interactions. The technique allows modelling of *functional* structures rather than organizational ones, which enabled comparisons between two FOAs that have similar business functions but different organization. The experiences from previous studies also showed that IDEF0 can realistically capture coordination and feedback both between and within business functions, which were key elements for the analysis of contextual constraints for harvesting activities applied in this study.

When the IDEF0 modelling technique is applied, the first step is to define a top-level function and viewpoint for the model. In the presented studies, this was defined as the *Harvest wood* function, and the viewpoint was harvesting operations management. Thus, any information that is not related to harvesting operations or its management can be considered irrelevant and unnecessary for later modelling. This exclusion of unnecessary information made the resulting process maps easier to read and enabled efficient modelling. Starting with modelling the inputs, outputs and controls (e.g. constraints) of the *Harvest wood function* (i), the rest of the modelling occurred through two separate steps (Figure 2). First, the function's interactions with other business functions at each FOA were mapped in a *context model* (ii) with enough detail to understand what constrained the function and which interdependencies it had with the other functions. To facilitate the analyses of differences, separate context models were created for three different planning horizons (strategic, tactical and operational). In the following step, a *detailed model* of the activities within the *Harvest wood* function was made (iii). Certain activities required further detailing into their sub-activities until a satisfying level of detail was met. All modeling followed the detailed IDEF0 syntax (NIST, 1993).

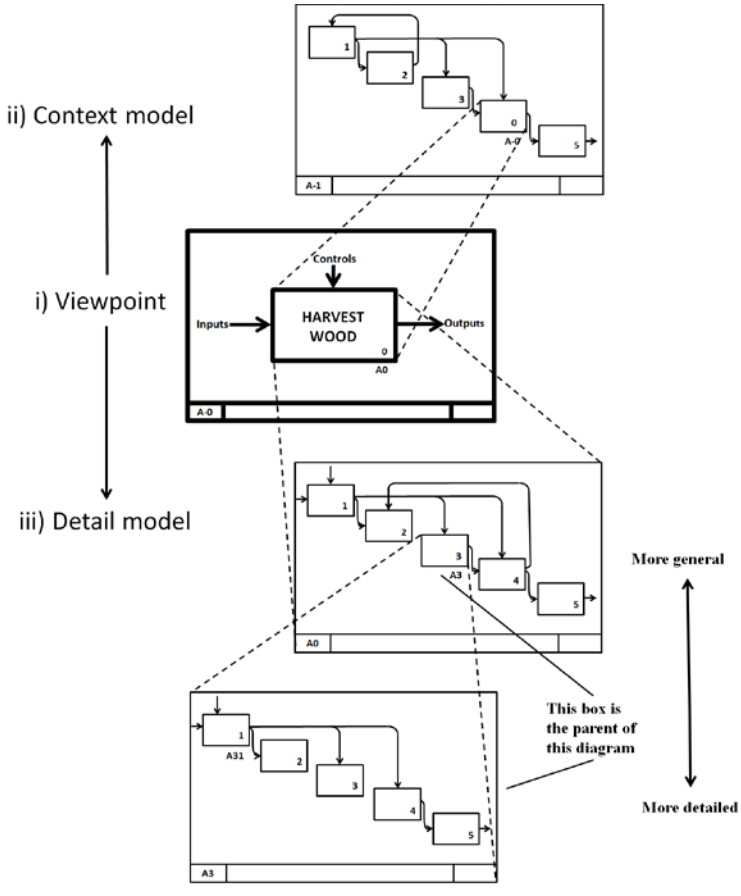

Figure 2. An illustration of the stepwise modelling (i-iii) and detailing procedures of IDEF0 function modeling. Based on NIST (1993).

The application of the IDEF0 technique was not perceived to be difficult, but it was work-intensive and required numerous model drafts, which included iterating comparisons between drawn models and the interview material. It was especially demanding to decide whether a described activity was similar enough to the descriptions of other respondents to motivate generalization or if it had enough unique characteristics to constitute a difference. Once all IDEF0 models were drawn, it was easy to visually pin-point differences and highlight them in the resulting figures. Based on the models and identified differences, the interview material was then analyzed again to understand what caused or explained these differences and what consequences they have for procurement, management and development of harvesting services.

2.3 The triad perspective: analyzing relationship success (II, III)

The second part of the research (Papers II and III) adopted the triad view on harvesting services to identify which values were perceived to be the most important by the three different parties (FOA, contractor and forest owners). The selection of respondents were again aiming for recruiting the *largest possible variability*. All interviews were conducted individually by phone, and in a structured manner with open-ended questions. Industry representatives, who had deep knowledge of the value of wood and its relation to harvesting operations, were interviewed first. These interviews aimed to identify factors that influence the value of harvested wood, as well as how these factors are affected by contractor performances. Production managers (one at each FOA) with the most contractor relationships were contacted next. This ensured experience with a diverse set of contractors, which, in turn, increased the likelihood of identifying different quality characteristics. These managers also represent the FOAs' links with industry customers and service customers (forest owners), and thus played a key role in understanding how different needs are balanced within the service triad. Again, *stimuli material* was prepared and sent in advance to the managers to aid them in the subjective categorization of their district's contractors (Figure 3). Through this approach, contractors were sorted into four categories based on their (perceived) performances in delivering both *production value* to the FOAs and *service value* to forest owners. The managers were then asked to explain why each contractor was ranked either high or low in the two different value perspectives, and what factors they had considered in their rankings. The mangers were also asked to name forest owners visited by each contractor who they knew had expressed satisfaction or dissatisfaction with the services. Finally, the managers were asked to suggest one contractor from each category to interview, and thus the research ensured contractor respondents who had attributes that varied as much as possible. These contractors were then interviewed concerning the values of planning conditions given to them by the FOAs, as well as their views on delivering service quality from the two different customer perspectives. The contractors were also asked to name forest owners whom they had provided services to and who had expressed satisfaction or dissatisfaction. When the forest owner respondents were chosen, those who had been named by production managers and/or contractors were primarily targeted to ensure the existence of service opinions. This approach could also potentially confirm, or extend, the information obtained from managers and contractors by discussing the same cases. The owners were asked to explain what they value in harvesting operations, if they were satisfied with recent operations, and what factors influenced their judgments of achieved quality.

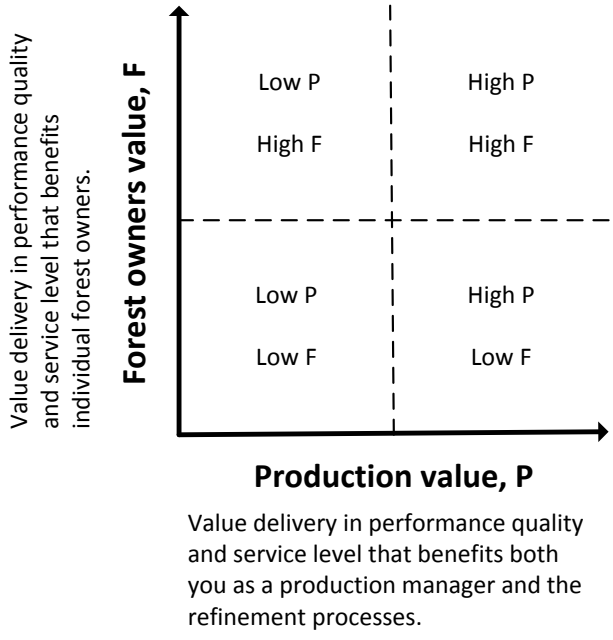

Figure 3. The matrix used to subjectively categorize district contractors.

Interviews were recorded, except for two respondents who declined this. In these two cases, extensive notes were taken instead. Transcriptions were not considered necessary, but the interview material was carefully analyzed to make lists of all the service values, and factors perceived to affect these values, mentioned by respondents. Values and factors where then compared and compiled per respondent group at each FOA, and these were used to form a total compilation, which resulted in three per-group lists that were the basis for the analyses in Papers II and III.

The next step was to collect as much quantitative data as possible about the identified factors that could be used in detailed statistical analyses of the service performances for all three perspectives for one calendar year (2013). To avoid disturbances in the data, the collection was restricted to contractors who only perform harvesting operations and for a single customer (one of the FOAs). The latter condition could only be determined for contractors who run their businesses as limited companies and whose financial data is publically available: thereby being comparable with billed amounts to the FOAs. For these contractors, data regarding operating margins were also available and could be included in the database. For both FOAs, this gave a sample of 42 contractors. Central staff managers were again interviewed in both face-to-face meetings and by telephone to identify what data were available and how it could be assessed.

Data regarding some factors were frequently followed-up by the FOAs and was delivered in its present form. IT managers from both FOAs were able to help extract additional data from IT systems, which were delivered in Excel files, along with code keys to identify which data belonged to which contractor (or to which machine). Similar data extraction was not possible from all systems, and in these cases, computers with the required software installed were borrowed from the FOAs for manual data compilation. However, no data were available for the majority of the identified factors, and it was also not possible to connect all of the collected data to specific contractors. In many cases, the available data were not complete for many factors, an occurrence that necessitated formulations of variable-specific criteria for minimum data content to decide what observations should be included in the analysis. Moreover, the resolution levels for the collected data varied largely; some data had the preferred monthly resolution while other data were only available with annual resolution. This extensive lack of data raised the need to develop questionnaires that could enable graded perceptions of performances and thus supplement the existing data.

Servqual was chosen as the instrument for creating questionnaires because of its proven applicability in a wide range of service environments since its introduction in the late 1980s (Ladhari, 2014), and recent experiences of the instrument's promising potential in measuring forest owners' satisfaction with harvesting services (Staal Wästerlund & Kronholm, 2016; In Prep. at the time of the study). The conceptual idea behind this instrument was especially interesting for the study since service quality is measured as the *difference* between *expected* and *perceived* quality. Thus, this instrument indicates how well the performance of a service supplier meets customer expectations (Parasuraman et al., 1985), and was utilized in the presented research to potentially measure the varying *needs* (e.g. expectations) of respondents rather than only grading perceived performances. For this reason, it was decided that this instrument would be employed in full-scale and that an entire paper (II) would be dedicated to the adaptation of the Servqual instrument for measuring harvesting service satisfaction in logistics triads and its application at the two studied FOAs.

Three questionnaires were designed based on a refined version of the original Servqual instrument by Zeithaml et al. (1990); one for each group in the triad. In accordance with the methodology, service quality was measured from five dimensions: 1) *Tangibles* — physical facilities, equipment, and appearance of personnel; 2) *Reliability* — ability to perform the promised service dependably and accurately; 3) *Responsiveness* — willingness to help customers and provide prompt service; 4) *Assurance* — knowledge and courtesy of employees and their ability to inspire trust and confidence; and 5) *Empathy* — the provision of caring, individualized attention to customers. These generic dimensions comprise 10

original aspects on service quality identified by the instrument's developers (Parasuraman et al., 1985). Since then, four aspects (*Competence*, *Courtesy*, *Credibility*, and *Security*) have been compiled into the A*ssurance* dimension, and another three (*Access*, *Communication*, and *Understanding the customer*) into *Empathy* (Parauraman et al., 1988; Zeithaml et al., 1990). This refinement into the remaining five service dimensions has been done through extensive statistical evaluation from applying the instrument and identifying the most important aspects, and their interconnectivity, for customer satisfaction (Parasuraman et al., 1988).

In the created questionnaires each of the five dimension included between three and six statements, totaling 20-23 statements. Each statement was repeated in two separate sections; the first concerned the degree to which a service component (factor) was expected from an excellent service provider (or service buyer in the contractor questionnaire), and the second section concerned the degree of quality that the specific contractor (or service buyer) had provided for that service component. Respondents answered each statement by circling a number in a seven-degree Likert scale, where 1 indicated strong disagreement and 7 indicated strong agreement. The dimensions were also weighted, and respondents were asked to divide 100 points among the five statements concerning the dimensions based on their relative importance to the respondent. A number of different satisfaction scores could then be calculated from the questionnaire answers according to the instructions of Zeithaml et al. (1990): *individual scores* (per service component); *dimension average scores*; *overall unweighted and weighted Servqual scores*; *unweighted and weighted total expectation and perception scores*. In principle, when the difference between perception and expectation scores is zero, the respondent's expectations are being exactly fulfilled. A positive difference means that expectations are being exceeded and a negative difference means that expectations have not been met, indicating a dissatisfied respondent. It should be stressed that the need of such a two-step approach (measuring first expectations and then perceptions) have been questioned: many studies have concluded the sufficiency of measuring only the perceptions of performances (Cronin & Taylor, 1992, Brown et al., 1993), and also the reliability of Servqual has been questioned motivated by an increased risk for biased results compared to using a non-weighted, performance based scale only (Cronin & Taylor, 1992). In comparisons, however, other studies have found merely small differences between the two approaches in measuring overall customer satisfaction (Rodrigues et al., 2011). The benefit of using Servqual for the research underlying this thesis was its provision of more nuanced results, as measuring also expectations helped to explore the causes of satisfaction or dissatisfaction of respondents. Such richness of data was desired,

and it could not have been assessed through simplified approaches: this has also been described as a main strength of Servqual by the developers when defending the instrument from other researchers' criticism (Parasuraman et al., 1994).

The adapted Servqual instrument was first tested on between two and four respondents from each group. Based on their comments, and test calculations to ensure satisfying levels of score variation, minor adjustments and clarifications were made to the questionnaires before they were distributed to the selected respondents at the two FOAs. Respondents were selected for the final application of the questionnaire based on the sample of 42 contractors. The contractors were contacted by phone, and 39 agreed to participate and to send questionnaires to their production manager and a sample of forest owners they had provided services for. They also approved the use of codes on questionnaires, which would enable linkage between all groups in their triad for the construction of a database that would be used during analyses. Questionnaires where then sent out to these contractors, their production manager, and the 10 forest owners to whom they had most recently provided conventional thinning or final felling services (with harvesting volumes >50 solid cubic meters) and who had a mailing address in Sweden. Also, the production managers (17) were contacted by phone to ensure responses, but the 390 forest owners only received a mailed package including a coded questionnaire with instructions and a stamped, addressed envelope for returning the filled-in questionnaire. The response rate for production managers was 100% without reminders. The response rate for contractors was only 62%, but this rose to 77% after they were mailed a reminder. Thus, unfortunately, nine contractors never responded despite their promise to do so over the phone. This restricted the sample of full triads to merely 30 contractors. For forest owners, the response rate was only 31%, which rose to 51% following a reminder. Some empty questionnaires were also returned with comments expressing an unwillingness to participate or uncertainty about having adequate knowledge to answer. However, many of the questionnaires filled-in by forest owners were incomplete; the most common event was that they had responded to few or none of the statements in the second part (perceptions of the service performance). In these cases, some had commented that they were unable to answer these statements as they had not visited the harvesting site during or after the operations. Consequently, only 43% of the forest owner questionnaires could be used to calculate scores and for some contractors this resulted in only one overall Servqual score. In comparison, seven scores could be calculated for the best case. Median values for forest owner scores were calculated for each triad in the analysis, but the large per-contractor variations in scores from cases with only one or few available scores raised uncertainty about the ability of specific

contractors to satisfy their customers. Other than this weakness, the resulting material was rich in variation and enabled the positioning of the relative performances of all three groups. The adapted Servqual instrument and its applications for ranking triad success and as a tool for managerial use were presented in Paper II.

The analyses for Paper II were performed using Minitab (V. 17.0, Minitab Inc., State College, PA, USA). Descriptive statistics and correlation analyses were used to investigate differences both within and between groups considering dimension weighting and the expectation and perception scores from the questionnaire results. The further analyses of questionnaire data presented in Paper III demanded multivariate statistical methodology to investigate the relative importance of dimensions and individual factors for explaining differences in perceived service satisfaction. PLS regression (projections to latent structures by means of partial least squares) was chosen because of the method's ability to rank the most important *x* variables that explain the variation of a dependent *y* variable (or several variables), and was implemented in SIMCA (V. 13.0, Umetrics AB, Umeå, Sweden). One PLS regression model was constructed per group using the group's weighted overall Servqual score as the *y* variable and individual factor scores and dimension weights as the *x* variables. A fourth model was also constructed for the contractor data, in which the operating margin was the *y* variable. For all PLS regression models, two components and unit variance (UV) scaling (default in the software) were used. Variable influence on projections (VIPs) were also calculated with the software. In accordance with instructions provided by the software, the average calculated VIP value for all *x* variables included in the model is 1. Thus, a VIP value >1 indicates relatively high importance compared to factors with VIP values <1, i.e. higher importance *x* variables explain more of the variation in the *y* variable than lower importance variables. In principle, the higher the VIP value, the more important the factor is for explaining variation in the *y* variable. In this way, the key factors (VIP >1) for all three groups could be identified and ranked by their relative importance based on VIP values. The *impact* of individual factors on satisfaction and profitability was also quantified by regression coefficients, which were calculated by the software. These complicated multivariate analyses were largely simplified by the use of SIMCA software; however, an expert in multivariate statistics was consulted to ensure accurate interpretation of the results.

Analyses of the remaining quantitative data primarily aimed to identify key factors for service satisfaction, but certain non-important factors (VIP <1) were also included due to the lack of data. Correlation and regression analyses (performed in Minitab) were used to investigate the relationships between

factors and other contextual variables. When sufficient data were available, the mean values and standard deviations of key factors for each contractor and the FOA district buying their services were calculated to enable comparisons of factor variation.

3 Results and discussion of Papers I-III

3.1 Varying FOA needs for service procurement (I, II, III)

Both studied FOAs operate in industrial contexts with high levels of uncertainty. In both associations, the strategic planning horizons varied between three to at most five years depending on present market stability, and the FOAs had estimated their annual needs for harvesting capacity over this time horizon. However, the uncertainty of such estimates increases as the time horizon increases due to uncertainties of market demand for roundwood and wood products, and of the degree of market competition for wood purchases. These uncertainties concern not only the supply and demand of wood volumes in general, but also the demand for different assortments and the availability of suitable harvesting sites to purchase from NIPF owners; all of these factors can potentially influence capacity needs. Also, there were *within* year uncertainties regarding the needed harvesting capacity that arose from temporary fluctuations in market demand and changing weather conditions that periodically restrict harvesting activities. The collected quantitative data for a sample of FOA districts confirmed *both* large variations in total delivered volumes of pulpwood and sawlogs during the studied year 2013 (Figure 4), *and* difficulties in predicting monthly outcomes of production (Figure 5), which reflect uncertainties and thus the great need for *flexibility* of harvesting capacity.

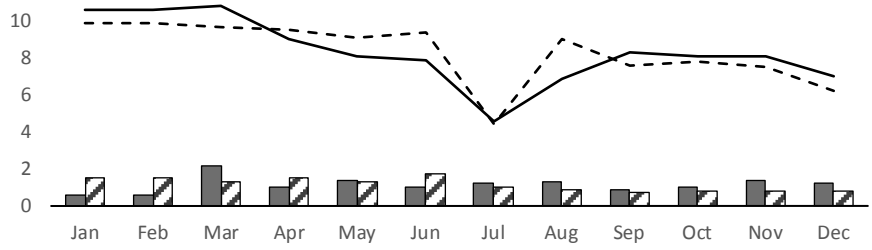

Figure 4. Variation in monthly shares (%) of the total annual delivery volumes of sawlogs and pulpwood for districts at the FOA without its own mills (9 sampled districts) and the FOA with its own sawmills (5 sampled districts), respectively, for the year 2013. Mean values are shown as lines and standard deviations are represented by bars (solid for the FOA without mills and dashed for the FOA with its own sawmills).

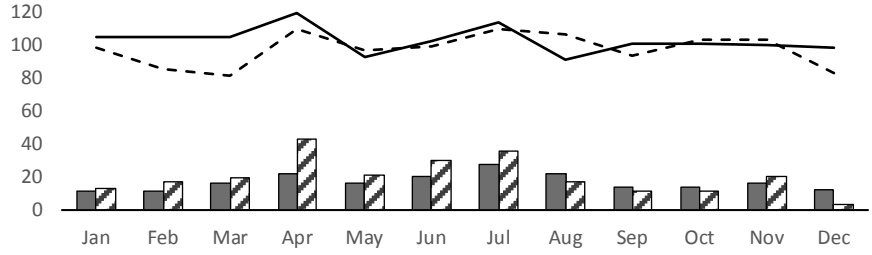

Figure 5. Variation in monthly outcome divided by the predicted monthly total delivery volumes (%) of sawlogs and pulpwood for districts at the FOA without its own mills (9 sampled districts) and the FOA with its own sawmills (5 sampled districts), respectively, for the year 2013. Mean values are shown as lines and standard deviations are represented by bars (solid for the FOA without mills and dashed for the FOA with its own sawmills).

Both FOAs had similar situations of supply uncertainties because they purchase most of their wood from their members or other NIPF owners. Neither association owned any substantial amount of forest, and members must, by Swedish law, be allowed to sell their wood to any other actor on the market; therefore, an FOAs is only able to control its supply situation and reduce uncertainty by increasing the cover time of current stocks of purchased harvesting sites. Concerning demand uncertainties, the two case FOAs had different situations as consequences of their supply responsibilities. The FOA that did not own mills only traded wood, and thus, had a full *external* supply responsibility[2] in comparison to the FOA with its own sawmills, which had a

[2] The FOA that did not own mills held a large proportion of shares in a sawmill group and consequently had increased its supply responsibilities (and business insights) to the external mills included in that group.

partial *internal* supply responsibility. The analyses revealed that these characteristics restrain the FOAs' production planning in different ways (Table 3); the FOA that solely trades wood commonly sold its wood to external mills through six-months fixed delivery contracts that consequently led to fewer short-term adjustments of planned production. On the other hand, the FOA with its own sawmills needed to make adjustments more frequently in order to continuously adapt to the changing demands of its own sawmills (revealed by the IDEF0 process mappings). Despite differences in the degree of uncertain short-term fluctuations, the uncertainty of *total* capacity needs *during* half-year periods was low at both FOAs. However, the uncertainty of capacity needs *for the coming period* was high for the FOA without its own mills due to low insight about the plans of external mills. For the other FOA, long-term uncertainty was lower due to full knowledge about the plans of its own sawmills.

Table 3. *The main contextual differences between the two studied FOAs*

FOA without its own mills	FOA with its own sawmills
Business task to sell wood with a profit	Business task to supply the own sawmills with high precision (the right volumes of the right assortments in the right time)
6-month *fixed delivery contracts*	*Continuous adaptations* to sawmills' demands
Few production adjustments required *in the short-term*	More planning activities and more *frequent production adjustments in the short-term*
High long-term uncertainty of the market's volume demand	*Low long-term uncertainty* of the sawmills' volume demand

Uncertainties in long-term demand and supply also resulted in corresponding flexibility needs for harvesting capacity between plan periods. The FOA without its own mills required a high level of flexibility between plan periods due to high uncertainty in both supply and demand. On the other hand, the FOA with its own sawmills required a slightly lower level of flexibility due to lower demand uncertainty in the long-term. A third Swedish FOA, which has both its own saw- and pulpmills and has been described in several previous studies (Carlsson & Rönnqvist, 2005; Audy et al., 2012; Kollberg, 2005), is characterized by even lower long-term uncertainty when compared to the two case FOAs, and thus, a lower required level of flexibility. Thus, the long-term flexibility needs of FOAs vary depending on the degree to which they process wood in their own mills. However, when the sourcing of wood is taken into account, FOAs operate in more uncertain contexts than many other Swedish forest companies that control large holdings of their own forest land (Figure 6). Audy et al. (2012) presented an international comparative study in which they analyzed the supply and demand uncertainties of Swedish forestry companies on a global level. When the

FOA that owns both its own saw- and pulpmills is positioned on their uncertainty scale, it is shown to experience medium uncertainty in both supply and demand.

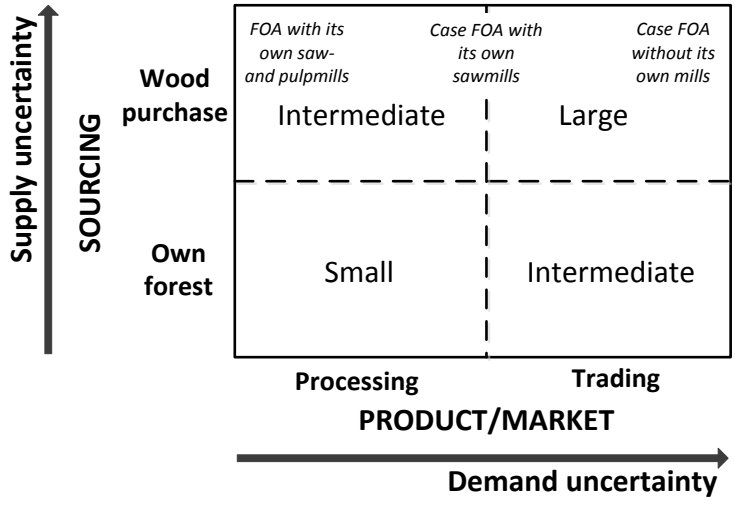

Figure 6. Flexibility need in harvesting capacity, depending on a forest company's contextual situation with corresponding degrees of uncertainty for wood supply and demand. Here, the two case FOAs, as well as an FOA with both its own saw- and pulpmills, are positioned.

For the procurement of production capacity a company must choose a suitable balance between *insourcing*, in terms of ownership of resources and employment of personnel, and *outsourcing*. The *extent* of outsourcing is influenced by the need for flexibility due to varying environmental factors, e.g. the seasonal nature of activities and frequency of fluctuations (Quélin et al., 2003), both of which are particularly relevant to harvesting activities (Carlsson & Rönnqvist, 2005; Uusitalo, 2005; Audy et al., 2012). From the long-term perspective, a company with low capacity uncertainty have better possibility to use the benefits of insourcing part of its needs so that it can gain a higher degree of *control* of its production resources in the sense of securing capacity and competence (Arnold, 2000). For companies such as the case FOAs, which have large needs for flexibility in both the short- and long-term perspectives, a large proportion of outsourcing is consequently largely motivated. As mentioned before, other reasons for outsourcing by FOAs and other Swedish forest companies include lowering financial risks, reducing the amount capital tied up in expensive machinery, and using competition to lower price levels (Norin, 2002; Eriksson, 2016). An outsourcing decision, however, is *not only* a choice between full insourcing with maximum control *vs*. spot purchases of services for maximum

flexibility, but spans a number of options in between (Figure 7). Both case FOAs aimed to secure a large proportion of the capacity need through long-term contracts (>6 months), and then satisfy the (short-term) flexibility needs through a sufficient proportion of short-term contracts or spot purchases. Two out of six interviewed production managers considered that they had the opportunity to use short-term contracts to some extent (>20% of their capacity needs), while the others considered it necessary to have a larger proportion of long-term contracts (>90%) to ensure sufficient capacity levels due to a perceived *lack* of contractors capable of fulfilling all service requirements. Two of these managers even contracted their *full* annual estimated capacity needs by long-term contracts. According to theory, such solutions could be motivated by the risks of opportunistic behavior among contractors, whose bargaining power increases when there are less service providers available, potentially leading to raised price levels (Vining & Globerman, 1999). To retain short-term flexibility in these situations, the managers had restructured their harvesting fleets to include a lower proportion of large machinery specialized for final felling and instead increase the proportion of mid-sized machinery capable of *alternating* between faster final felling operations and slower thinning operations. The utilization of less specialized machinery was considered to increase costs per harvested unit in final felling (however, harvesting costs are paid for by the forest owners), but was also considered to potentially decrease the time and distance contractors spent relocating between harvesting sites.

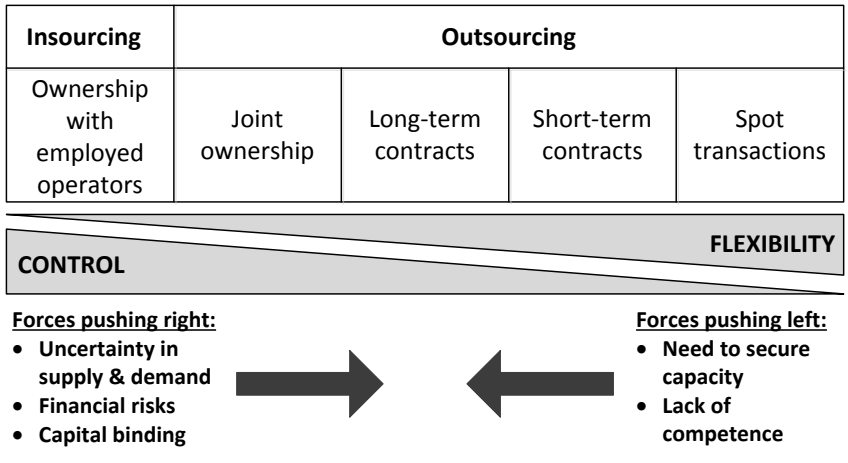

Figure 7. Structural alternatives in the outsourcing design for a forest company that provide varying levels of control and flexibility (based on Arnold, 2000), as well as the main forces that influenced the outsourcing decisions among the studied FOAs.

In light of the results concerning contextual situations presented above, it was not surprising that managers at both FOAs highly valued the *flexibility in harvesting volumes* characteristic of their harvesting contractors. Another factor that managers highly valued was *delivery reliability*, which describes a contractor's ability to produce expected wood volumes at a designated roadside landing within a given timeframe. A wood selling manager at the FOA without its own mills especially emphasized this factor, and considered individual contractors to have key roles in the production system's ability to deliver agreed volumes to industry customers with high precision. Failures in deliveries to customers did not necessarily increase the risk of losing customers or necessitate immediate price reductions, but did lower the FOA's bargaining power in negotiations for the next contract period and thus, could potentially decrease future payment levels for produced wood. The ability of contractors to send complete and frequent production reports about harvested and forwarded wood was also considered highly important to enabling the accurate planning and management of an FOA production system. In addition, the importance of the bucking performance of sawlogs during harvester production increased with the sawlog volumes a contractor produced, but this factor was still considered less important than delivery reliability and flexibility. This factor was also considered less important in operations with a small sawlog output, e.g. in all early thinnings, during which mainly pulpwood is produced. In addition to these factors, mangers valued a contractor's ability to operate independently and maintain professional communication, as well as the ability to satisfy forest owners and actively assist in creating new business opportunities. Naturally, a low price level for the delivered services was also considered when associating high value to a specific contractor.

Interestingly, the statistical analyses of questionnaire data (Servqual) and the considered factors revealed that flexibility ranked as low as number nine (out of 22) in variable importance for explaining the variation in manager satisfaction and delivery reliability was ranked as number 10. The most important factors were instead those related to *trust* and the ability to appear and act in positive manners towards *forest owners*. Surprisingly, all factors associated with bucking performance showed little importance (VIP <1) to explain variations in manager satisfaction. This is contradictive to previous studies, which have reported that these performances are the *main* quality characteristics in evaluations of contractors (Högnäs, 2000; Eriksson & Lindroos, 2016). Eriksson & Lindroos (2016) specifically identified bucking performance as part of the *core* service valued by managers at an integrated forest company, while flexibility and delivery performance were merely considered as *additional* services. However, Eriksson et al. (2015) also emphasized that the factors valued by service

customers are potentially *case specific*, which confirms the idea presented in this thesis that different industrial contexts have varying influences on the factors that FOA managers consider most important. When the relatively low importance of operations performances to FOA managers is considered, it is quite remarkable that managers focused on these aspects (mainly bucking performance) in their follow-ups of contractors. An explanation for this could be that bucking performance data are automatically generated and require little effort to assess, and poor performances directly translate into monetary losses in the value of produced sawlogs. At least in final felling operations, which generally produce large volumes of sawlogs, *sufficient* bucking performance could be a so-called *must-be quality attribute*, whose absence might cause manager dissatisfaction even though the presence does not significantly contribute to satisfaction (Yang 2005). What was *far more surprising*, and a clear weakness for both FOAs, was that very little attention was given to the variables that have *larger* importance for managers' total satisfaction of contractor performances. This may be due to the managers' perceptions that they have limited time available for follow-up activities. Based on these results, the studied FOAs, as well as other forest companies, may find it useful to reconsider the attention they have assigned to *conventional* follow-up variables (described in previous studies) and how this compares with the attention assigned to other variables that may be more important for service quality in supply situations mainly based on wood purchases from NIPF owners.

3.2 Varying contractor needs for achieving success (I, II, III)

While FOAs want their procured harvesting capacity to have high flexibility at a low price, contractors desire the opposite. Interviewed contractors (part 1) commonly had investment cycles for their machinery that ranged from four to six years. During this time period they need not only sufficient payments per harvested unit to cover costs, but also the security of *high machinery utilization* to ensure profitability for their expensive investment (as shown by Mäkinen, 1997). Contractor profitability simply requires higher incomes than costs, and the *conditions* provided by FOAs play a crucial role in the efficiency of contractors, and thus, their possibilities to offer attractive (low) price levels for the services they provide FOAs. In principle, an o*ffered price per harvested unit* must cover both the *estimated costs* and the desired *profit margin*, and the latter should also reflect the *involved risks due to uncertainties* (Norin & Furness-Lindén, 2008). Similar to FOAs, increased long-term uncertainty in demand (for services) should translate into increased financial risks for the contractor. Thus, *longer contract periods* with service buyers and *guarantees for sufficient income*

will lower this uncertainty and better enable the contractors to make *accurate cost estimations*, which will correspond to lowered needs for risk compensation in price offers. Furthermore, it is well known that better planning conditions provided by service buyers (FOAs) enable higher operations efficiency for contractors (Greene et al., 2002; Spinelli, 2008; Norin & Furness-Lindén, 2008). A portion of this potential of course depends on the abilities of individual contractors, but nonetheless, their possibilities for achieving high efficiency are largely restrained by their operating conditions. It should be noted, however, that unwillingness due to practical difficulties has been shown among service buyers to apply *differentiated pricing models* for varying uncertainty and risk factors between contractors (Norin & Furness-Lindén, 2008), and to avoid such models for mechanized forest operations was early recommended for the sector due to risk for extensive administrative costs (Lönner, 1965).

When the interviewed contractors were asked about high machinery utilization, most preferred to view this aspect as a maximization of the proportion of invested working time that actually generated income. Many contractors revealed that the most important parts of conditions provided by their FOA district managers were those affecting machinery utilization. A variety of factors affect machinery utilization, such as the degree of clustered sites for minimizing time and distance for relocations, high-quality planning information and directives, and well-prepared sites (field markings, roads, snow-clearing, and other) that enable fast start-up of operations. Conditions that increase the *operational efficiency* in terms of harvested volume per time unit include sufficient time horizon for site instructions which enables contractor pre-planning, clear field markings that are easy to follow, and pre-clearing of undergrowth which increases the visibility and accessibility at sites. Also, forest owners were considered to potentially influence efficiency, e.g. by frequently visiting sites and thus interrupting operations. One contractor emphasized how frequent errors and poor site preparation negatively influence the relationships between contractors and FOA managers. Notably, contractors' perceptions that FOA managers make efforts to help solve arising problems during operations showed *uniquely* high importance (VIP 2.2; correlation coefficient 0.457, p-value 0.011) for contractor profitability.

Contractors also highly valued the provision of an *even level of employment* from the FOAs in terms of evenly distributed incomes and costs between months, and the statistical analyses revealed the perception of evenness to be a *key factor* for contractor profitability (VIP 2.1; correlation coefficient 0.451, p-value 0.012). The analyses also showed that variations in work levels were largely affected by districts' variations in delivery volumes, and that variations in contractor volumes were larger than those for districts; this finding could be

explained by the seasonality of forest work, which requires temporary increases in work volumes to buffer for thaw or rain periods and industry vacations (Uusitalo, 2005; Carlsson & Rönnqvist, 2005). However, managers could, to some extent, reduce the effects of large volume variations on income levels (Figure 8) by using production regulators; the statistical analyses identified the main regulatory mechanism being to vary proportions of thinning and final felling, combined with actively selecting sites with larger (faster) or smaller (slower) average stem volumes in thinning. The ability to vary the proportions of operation types was possible because of the wide-spread use of mid-sized machinery. Of course, the possibilities to be flexible in this respect is again limited by a district's current stocks of purchased sites as was previously demonstrated by Gautam et al. (2013). Improved evenness could potentially reduce contractor costs by avoiding the need to compensate their employed operators for overtime. However, in accordance with industry standard terms, FOAs do pay some compensation to contractors for sudden FOA-ordered standstills that exceed the arranged tolerance limits to cover salaries and capital costs (www.apse.se). Considering the extensive use of production regulators for varying levels of harvesting volumes at the FOAs, a potential risk can be identified for contractors in the standard way of making contract agreements for harvesting volumes without complimentary agreements also on income levels and tolerable fluctuations thereof. Interviewed contractors also explained that as long as information about planned standstills or production changes was given in time, they were able to re-plan their working schedules with vacations or machine service, for example, and thereby reduce the potential negative effects on profitability. The statistical analyses also showed this to be an important factor for contractor satisfaction. However, perceptions of timely planning information did not show importance (VIP <1) for profitability. On the other hand, perceptions of receiving *timely site instructions* showed high importance for explaining variations in profitability (VIP 1.6). Interestingly, the interviews with production managers revealed that they employ two distinct approaches for providing contractors with planning information: (i) some managers did not provide any information but *definite full instructions* for harvesting and bucking, thereby avoiding potential contractor errors arising from needs to retract or change information caused by commonly occurring differences in actual and estimated outcomes of production; (ii) other managers gave some *preliminary information* about harvesting sites, for example, their geographical locations, earlier during the planning process to aid contractors in their pre-planning activities. However, the need for such preliminary information varied between contractors, as some described preferring to undertake pre-planning while others reported that they did not conduct any pre-planning.

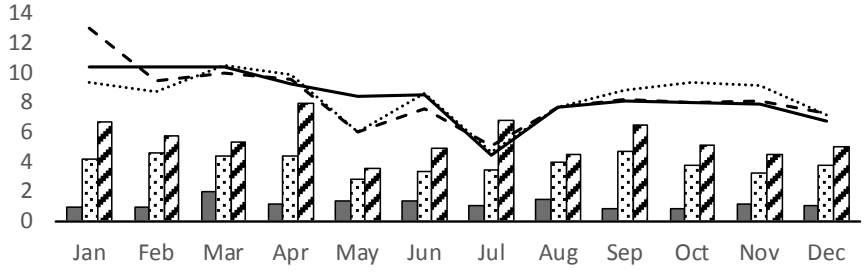

Figure 8. Differences in the variations of district volumes and contractor work levels. Mean values (lines) and standard deviations (bars) for monthly shares (%) of the total annual delivery volumes (sawlogs + pulpwood) per FOA district (solid lines and bars, small variations) compared to the annual harvested volumes per contractor (dashed lines and bars, large variations) and the annual contractor income received from their FOA (dotted lines and bars, intermediate variations).

A striking result was the noticeable difference between factors that were associated with contractor *satisfaction* and factors associated with *profitability*. Factors such as FOA managers' empathy, respectful treatment, and trustworthy behavior showed great importance in explaining variations in contractor satisfaction, but these factors had little or no importance for explaining profitability. VIP rankings even revealed that contractors who assigned great importance to managers' empathic abilities for satisfaction had lower profitability. In comparison to both production managers and forest owners, contractors' satisfaction with the conditions provided by FOAs did not only depend on their perceptions of FOA performances, but also on the *expectations* they had for various conditions. In general, satisfied contractors had *both* low expectations and high perceptions of provided conditions. These varying expectations could potentially reflect differences in contractor needs. Profitability is necessary for business survival, but evidently it does not necessarily need to be high for some contractors to still feel satisfaction with their working conditions. These results are similar to those from a Canadian study by Drolet and LeBel (2010), which identified *wellbeing* as a stronger motivator among many forest contractors than achieving large profits. Hence, the main concern of an FOA, or another service buying company, should be to provide good conditions that enable *both* satisfaction and (sufficient) profitability for highly valued contractors. This would ensure success from both aspects and help maintain stable and well-working business relationships.

3.3 Varying forest owner needs for perceiving satisfaction (II, III)

The forest owners were, without doubt, the group of respondents that differed most in terms of the factors they valued for harvesting services. This was also

reflected in the questionnaire results, as the forest owners demonstrated the highest variation in both expectations and perceptions for most service elements. What all forest owners had in common, however, was *a fear of damage* to soils, roads, cultural remains and remaining trees caused by operations. While both FOA managers and contractors valued high operations efficiency highly, many forest owners did not necessarily consider this factor to be as important. This was notable for *thinning operations*, as some forest owners specifically expressed a willingness to pay extra if the contractors were careful to avoid causing damage. The analyses of questionnaire results also revealed that forest owners viewed contact by the harvesting crew *if* any problem or error occurred to be important, and even more important was the perception that the harvesting crew would make an *effort* to solve such problems in agreement with the forest owner. However, the most important factors associated with forest owner satisfaction were trust, respect and individual attention, and concern for the forest owners' needs. During the interviews many forest owners also emphasized the importance of *recurring* harvesting crews that had proven themselves to be trustworthy in previous operations. One forest owner even specifically said that the only reason for him to sell wood to his FOA was because he desired one specific contractor who he trusted and to whom he was loyal, a statement which was confirmed when interviewing the contractor. Another contractor also described his active focus on satisfying forest owners, and he said that he had many loyal forest owners who had followed him to the FOA when he had stopped offering services to another wood buying company competing with the FOA. These results add another aspect to the importance for FOAs to have long-term relationships (and contracts) with their service suppliers, as these actions could potentially increase competiveness on the market for NIPF purchases. It also builds upon the findings of Staal Wästerlund & Kronholm (2016), who identified loyalty among forest owners to be directed not only to FOAs but often to specific wood-buying managers; evidently, loyalty can be also directed to service suppliers. Forest owners who did not have experiences of their own with a harvesting crew often listened to recommendations from other local forest owners; one forest owner had ordered his FOA not to send a specific contractor due to a bad reputation. Interestingly, the production manager considered this contractor to be a top-performer in both operational quality as well as in ability to achieve forest owner satisfaction. The manager explained that this bad reputation followed the contractor from an event many years ago, and that the previous bad outcomes that had dissatisfied forest owners were due to conditions given by FOA managers, which were *not even controllable* by the contractor. In this way, contractors are dependent, to a certain extent, on FOA planning conditions to be successful in satisfying forest owners.

Perhaps the most striking result concerning forest owners' satisfaction was that none of the interviewed forest owners checked a contractor's work in terms of operational performances, such as thinning density, bucking or compliance with standards for forest management and environment certification. Most did not have adequate knowledge to conduct checks for any of these operational outcomes. Instead, they based their judgments of service quality purely on the *consistency of performed services with their request* and on the *visual appearance* of harvested sites, i.e. the extent of damage, as well as how neat and appealing they found the end result. When questioned about compliance with standards, the forest owners expressed that they trusted operators to follow FOA directives and most showed little or no concern for failure in this respect. It may be difficult for a forest owner to determine that a harvesting service has a poor financial outcome, as this would require consideration of not only the condition of the remaining forest stand and ground, but also the value of the harvested wood and the cost of the operation (Follo et al., 2006). Thus, contractors could potentially be favored among forest owners because of the social and communicative skills of their operators even if they actually perform poorly in functional or financial terms. These results revealed a need to develop objective tools that forest owners can use to assess practical performance rather than grading quality on merely visual impressions and aesthetic feelings. These tools, which could increase forest owners' *awareness* of financial outcomes, may demonstrate a widely different outcome of measured service satisfaction from what is indicated by the studies presented within this thesis.

3.4 Assessing success from the triad perspective (II)

The application of the adapted Servqual instrument to all groups (FOAs, contractors and forest owners) enabled the development of a model that can be used to position and rank relationship success from an individual triad perspective (Figure 9). The model consists of three axes that are scaled according to ranges in overall weighted Servqual scores for each group, and the axes have a mutual connecting point where the minimum values of each axis meet. Contractor scores constitute the model's mutual *y* axis. The satisfaction frontiers (dashed lines) are drawn between maximum values (axes ends), resulting in a triangle that demonstrates the potential maximum of triad satisfaction as observed for all perspectives. The positioning of an individual triad's scores within the model constructs an inner triangle, and its size in comparison to the outer (frontier) triangle enables the calculation of *relative triad satisfaction*. Based on this concept, a *triad satisfaction index* was calculated for all of the 30 complete triads, constructed from surveyed observations for all three groups

(production manager scores, contractor scores and median forest owner scores), as the proportional size of the inner triangle area compared to the outer (frontier) triangle area. *Relative per-dimension indexes* were also calculated as the proportion of each inner triangle axis length compared to the corresponding outer triangle axis length. Optional *harmonized triad satisfaction indexes* could then be constructed from these individual indexes by calculating the average of all three indexes; in this way, the otherwise relatively large impact of contractor scores (the mutual *y* axis) could be reduced so that it is proportional to the impacts of the other two scores on total triad satisfaction. The *ranking* of the 30 complete triads presented in the research underlying this thesis was, however, done based on the relative per-dimension satisfaction indexes.

Based on the presented results and comparisons to aforementioned previous studies, FOA managers evidently value many other factors in their evaluations of contractor performances than managers at other Nordic forest companies operating in different industrial contexts; e.g. the case of an integrated forest company described by Eriksson et al. (2015, 2016) or the case of a state-owned forest company described by Högnäs (2000). As mentioned before, managers appear to assign different *weights* to common factors among companies. Eriksson et al. (2016) emphasized the importance of *alignment* between contractors and service-buying companies in their mutual satisfaction, and also showed its importance for contractor profitability. A well-aligned relationship in their case is, however, dependent on satisfaction from only two perspectives, while FOA alignment requires *satisfaction from all three service perspectives* and forest owner satisfaction also influences the total satisfaction of managers. For contractors, service satisfaction from both customer perspectives should obviously be the main target. However, the analysis of performances based on the triad positioning model revealed interesting cases in which contractors succeeded relatively well or even excellently from one customer perspective, but performed poorly from the other. The two contractors in the triads presented in Figure 9 are examples of such cases. If only *conventional* performance indicators (from merely the manager perspective) were applied to the evaluation of the contractor in the triad, ranked as number 28 out of 30, this contractor would be relatively highly performing (72%) compared to others. However, when two other perspectives are considered, as suggested in the research underlying this thesis, the contractor fails in total triad satisfaction (8%) due to relatively poor performance from the forest owner perspective (26%) and dissatisfaction with FOA conditions (16%). The other contractor in the triad, ranked as number 4, would be considered a *low-performer* if the conventional methods were applied (33% from the manager perspective), but is actually a *top-performer* from the forest owner perspective (91%) and is also very satisfied with his/her conditions

and work situation (98%). Thus, the question is: *which of these contractors holds the highest value for an FOA*? This question cannot be clearly answered based on the results of the research included in this thesis, but concerns can be raised regarding the sole use of a manager perspective to evaluate performance. When the imbalance in FOA managers' follow-up factors, where the extent and frequency of factors from the manager perspective largely outnumbered factors from other perspectives, is considered, a weakness in current management of business relationships can be identified. The currently applied follow-up and evaluation models include a risk for *overvaluing* a contractor relationship, such as number 28, and *undervaluing* the performances of other relationships, such as number 4. Thus, a recommendation is that FOAs and other wood-buying companies *tailor* their follow-up models to fit specific contexts and better reflect the values that matters most; not only those concerning the company as a whole, but also those that concern the varying values and needs in individual service triads. At least for the FOAs to design models that follow up performances from the triad perspective, rather than from the separate dyad perspectives currently applied, is a necessary prerequisite to focus development efforts and improve business relationships.

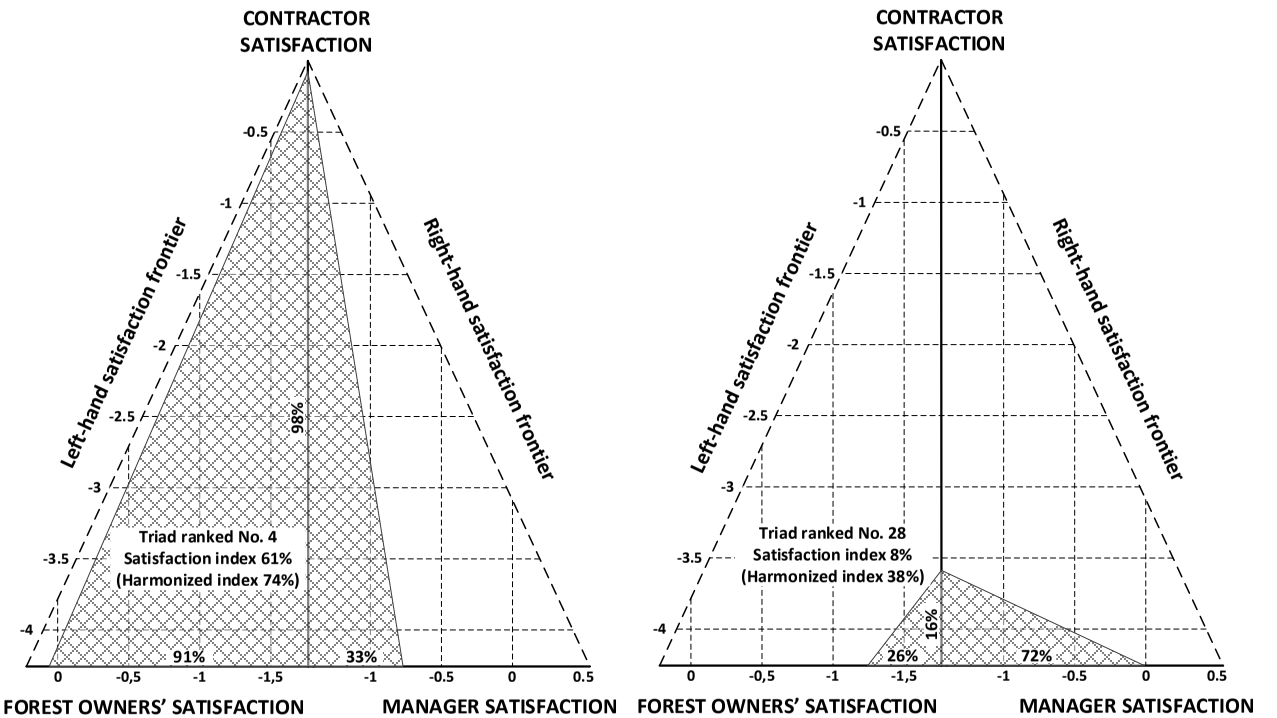

Figure 9. Examples of the measured total satisfaction for two surveyed triads, which are positioned within the proposed triad positioning model. The model is scaled in accordance to ranges in respondents' overall weighted Servqual scores for service satisfaction. Each of the three scales has its minimum value at the three axes' mutual connecting point, and satisfaction frontiers (dashed lines) are drawn between observed maximum values for each respondent group. Each inner triangle is constructed by a case triad's obtained satisfaction score (ranked No. 4 vs. No. 28 out of the surveyed 30 triads), and their relative size in comparison to the potential maximum of the outer triangle (frontiers) constitute the triads' satisfaction index (61% vs. 8%)

4 Concluding discussion

4.1 FOAs' needs to tailor business models to fit local contexts

The survival and success of a firm depends on its ability to stay competitive, necessitating strategies that will result in competitive advantages (Porter, 1991). Despite its somewhat unique context as a forest owners' cooperation, an FOA, like any other company, must struggle for its competitiveness and to keep or improve its market position. The wood-selling respondent at the FOA without any of its own mills indicated that large, external industry customers could not fully change their supplier to another wood-trading company due to the large market shares that the FOA boasts. However, they could still use the available competition to pressure for reduced price levels from the FOA, especially if the FOA failed in its delivery precision. Thus, for a Swedish FOA, or any other wood-trading company, persistent competition for industry customers can be assumed in all geographic regions. As mentioned before, an FOA not only faces competition for customers purchasing produced wood or wood-based products, but also for wood-supplying forest owners who are free to sell their wood to any other market actor. Even in situations of low competition, FOAs must offer satisfactory services to forest owners, who, due to general low dependencies on forestry incomes, can choose not to harvest if the offered wood prices or services are unattractive (Mattila & Roos, 2014). Furthermore, sufficient customer satisfaction must be achieved to secure loyalty and stability in wood supply (Staal Wästerlund & Kronholm, 2016). In light of such market contexts, the findings from the research presented in this thesis that *forest owners' satisfaction* and *delivery reliability* are important to an FOA manager's perceived value of contractor services can be readily understood; these are two key aspects of harvesting services that ensure *stable wood supply* and *profitable wood sales*. When an integrated forest company holding both its own forests and mills is considered, these two aspects could be assumed to have less importance. This was confirmed in the findings by Eriksson (2016), which reported that

respondents held factors such as bucking performance and log quality more valuable than delivery reliability, and did not consider values of achieving forest owner satisfaction in wood purchases. Factors associated with operational performance, such as bucking, also seem to be commonly used determinants of quality in harvesting services (Högnäs, 2000; Eriksson & Lindroos, 2016), and thus, represent a *business norm* for grading contractor performances in Nordic forestry. Factors associated with these quality norms were also those that were mainly followed-up on at both FOAs presented in this thesis, despite evidently being less important to the perception of service quality and satisfaction than factors from other service perspectives. The importance of customer satisfaction for various supply and delivery contexts under different degrees of market competition is visualized in Figure 10.

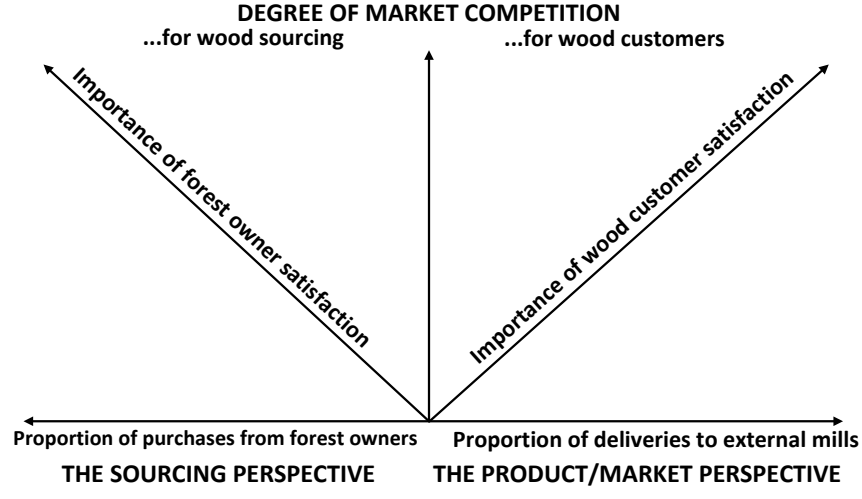

Figure 10. Principle model of the importance of customer satisfaction from both the sourcing and product/market perspectives, depending on proportions of purchases from forest owners and deliveries to external mills vs. degrees of market competition.

A company with such large flexibility needs as an FOA could be expected to use a large proportion of short-term contracted capacity for service procurement (Arnold, 2000), which has also been recommended for Swedish forest companies (Furness-Lindén, 2008). However, managers at most studied districts of the two case FOAs perceived a lack of contractors capable of fulfilling all service requirements. Thus, managers at these districts needed to face competition from yet another perspective necessitating the *tailoring* of their business model to fit their current local situation, and as revealed by the results,

the generic solution was to make long-term contracts but retain flexibility by requesting contractors to purchase less specialized machinery that can alternate between final felling and thinning operations. These decisions are, however, contradictive to the current business recommendations of using large, specialized machinery in final felling, which has been proven to be the most cost-efficient approach and provide the best conditions for high measurement precision in bucking (Arlinger et al. 2014). A situation of few available contractors also excludes the possibility of applying tendering procedures, which use competition among contractors to generate the lowest possible service prices, which was a widely applied model by Swedish forest companies during the 2000s (Norin & Furness-Lindén, 2008). From the contractor perspective, however, this development is positive, as most contractors desire long-term agreements that lower their uncertainty and risks.

For a company that owns large forest resources, low costs in forest operations is a key issue for profitability. Cousins (2005) showed that cost-focused firms generally view the role of supply to be cost minimization, and reducing costs has indeed been a major focus throughout the development of modern Swedish forestry (Eriksson, 2016). One important approach to cost minimization is standardization (Cousins, 2005), and in forest companies this is reflected by *standards for forest management*. For companies that do not need adaptations for different customers, or to balance different customer interests, services can be highly standardized (Hertz & Alfredsson, 2003) and operational collaborations can be expected to focus on short-term developments that target cost reductions (Cousins, 2005). In contrast, the managers of the studied FOAs desired their contractors to have *both* the ability to balance between forest owners and FOA interests as well as to adapt to specific forest owner requests meant to achieve customer satisfaction. Thus, the FOAs have large incentives to abandon forest management standards on specific harvesting sites, as long as laws and environmental certifications are followed. In the case of an FOA, the *costs for operations are paid for by the forest owners* and does not influence FOA profitability. The ability to offer a standardized service at a competitive price is of course also important for FOAs, but as long as forest owners with deviating requests accept less profitable outcomes, the FOA should consent to high degrees of customer adaptation, especially in situations of high market competition for forest owners. As building trust with forest owners is crucial for achieving loyal wood suppliers (Staal Wästerlund & Kronholm, 2016), the FOA must, in turn, be able to trust its service suppliers. The trust and goodwill of a service supplier lowers the uncertainty of performance qualities, and interpreted in light of Cousins (2002), this would give FOAs further incentive to develop long-term relationships with well-performing contractors that have proven

themselves to be trustworthy. This also requires goodwill and proven trust from the FOA side, which raises the importance for managers to provide conditions that ensure contractor satisfaction, especially if there are few alternative qualified contractors available on the market.

In conclusion, companies have different needs for tailoring their business models for harvesting services depending on their industrial contexts and corresponding degrees of competition for *external industry customers*, *forest owners* and *qualified contractors*. Based on the results from the research presented in this thesis, an FOA district could therefore have several well-grounded reasons for adapting or even abandoning the business norms and shifting to an approach where service elements are tailored to fit a specific local context. A simple conceptual framework for the need for FOAs or other forest companies to tailor their business models with respect to actual local competition is described in Figure 11. However, the presented framework assumes that there is persistent competition for external industry customers.

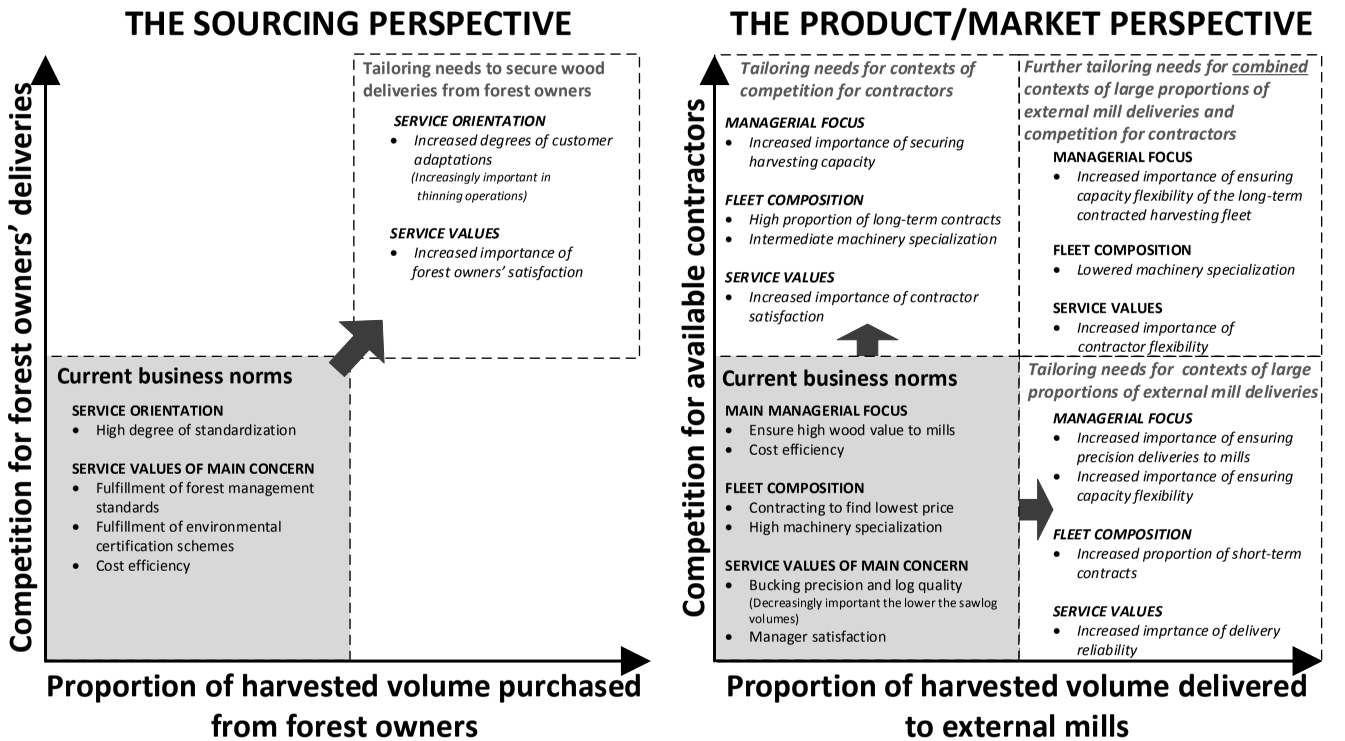

Figure 11. Conceptual framework illustrating the need for FOAs or other companies to tailor their business models for harvesting services (compared to current business norms) based on industrial contexts for sourcing and product/market, respectively, and on degrees of local competition for forest owners' deliveries and for contractors capable of fulfilling all service requirements. The framework assumes that there is persistent competition for external industry customers.

4.2 Development needs for service triads in FOAs

Along with tailoring their business models to reflect the most important service values of each group in the triad (FOA managers, contractors, forest owners), both case FOAs needed to adapt their follow-up models by assessing more parameters than would be conventionally used and refocusing their follow-up efforts through the prioritizations of different values. Neither FOA had yet translated perceived service values into monetary terms in more than a modest extent; based on the conducted interviews, only the economic effects of bucking performances are currently being considered. However, many interviewed FOA managers perceived values in delivery reliability and production reporting, while forest owners expressed willingness to pay for extra care during thinning operations, and a contractor's profitability was affected by the evenness in provided work levels. The quantification of these values in monetary terms is highly important when assessing service development or discussing the pricing of services. The problem for a service buying FOA to estimate the monetary value of high performances, in this case referring to conventional factors concerning bucking and delivery reliability, was noted already 10 years ago by Norin & Furness-Lindén (2008). They recommended that once *threshold levels* of performances can be guaranteed by the bidding contractors, the offered price level per harvested unit may decide who wins a contract. In contrast, they however also stressed a common problem in the Swedish forest sector of lacking monetary incitements for contractors to improve their performances, which was desired by the evaluated FOA (Furness-Lindén & Norin 2007; Norin & Furness-Lindén, 2008). Evidently, this problem still remains, and concerns also many other aspects of service performance, which calls for a new approach from FOAs.

Ensuring contractor satisfaction is not only important to keeping highly valued contractors associated with FOAs, but also from a wider sector perspective; together with other service buying actors, FOAs have a responsibility to increase the satisfaction of contractors and machine operators, thereby contributing to an increased *attractiveness* of the profession and a stable long-term supply of qualified operators that will satisfy the sector's need. Certain generic standards and templates currently exist for the contracts and agreements between FOAs and contractors in the Swedish forest sector (www.apse.se). The importance and effects of included contract parameters should be thoroughly analyzed to identify areas that could potentially be tailored and the values that are involved in the various parameters. Also, there should be an incentive for FOAs and other companies to understand both the general and contractor-specific values of their offered contract conditions for *individual* business relationships to achieve contractor satisfaction and efficiency in the

pricing of services; e.g. by balancing business risks between the two parties with corresponding adjustments in price levels.

Standards are important to define what should be included in basic services, and an instrument to control costs. However, the varying values among service-buying forest owners identified in the research underlying this thesis constitute grounds for frequent abandoning of forest management standards to achieve customer satisfaction. The current generic standards could potentially be developed into a *selection* of defined services, which could include basic services and a number of optional services that correspond to what is most commonly requested by forest owners. Previous studies have emphasized the need for the development of *new* services (Mattila & Roos, 2014), but there are already clearly defined alternatives for current harvesting services in thinning with well-described advantages and disadvantages of different tree selection methods for a forest stand's future development *vs*. costs and profit levels of an operation (Agestam, 2015). To define also *other* alternatives for harvesting services based on the currently applied standards would enable individual forest owners with poor knowledge of forest management to choose between options where it is easy for them to make a balanced choice between costs and advantages. Further studies could investigate which other service elements have the potential for such definitions of alternatives. Kronholm (2016) has also stressed the need for FOAs to develop these types of *customized* business offers.

The research underlying this thesis revealed that some service elements are, actually, already frequently customized. Formal service agreements are made only between the FOA and the forest owner, as a complement to the wood purchasing contract, and these agreements are to be communicated to the contractor through harvesting site instructions. However, *additional informal agreements* are commonly made between the forest owner and the contractor, without involving the FOA, and thus they are never formalized in a proper contract. This lack of formal agreements is potentially a problem, which the FOAs should consider in their development efforts for improved services and management. A direct dialogue between forest owners and contractors, with resulting continuous adaptations, has however been described as desirable by all parties of the triad. Therefore, there is potential in developing an interface facilitating direct communication and agreements between all parties. Through the interface, some agreements should be possible to formalize into contracts when needed. Such an interface would also promote direct and immediate feedback from forest owners to contractors, which currently is being given mainly through FOA managers.

The research further identified a lack of tools that forest owners can use to evaluate the value of service performances, and this is an important step in

service development; it is crucial for driving quality development by other means than visual impressions and feelings. Such tools could lower the risk of undervaluing well-performing contractors who suffer from bad reputations or poor communicative skills. Again, the FOAs have a large responsibility to initiate and drive the development of such tools, as they are institutions that represent knowledge dispersal and data compilation.

As large forest actors and the main institutional representatives for the non-industrial, privately owned forests in Sweden, FOAs can be expected to significantly contribute in the societal shift towards a bioeconomy, in which the forest sector has emphasized its role and realized the benefits of being an integral part (Kleinschmit et al., 2014). Such a shift requires the development of new forest-based products, increased resource efficiency for economic competiveness, and increased responsibilities for sustainability from both an environmental and social perspective (Schmid et al., 2012). As shown in the studies included in this thesis and previous studies, forest owners as a group have limited knowledge of the potential uses of their produced wood and consequently cannot be expected to know what services they should demand. Thus, FOAs must lead the development of harvesting services to meet society's expectations and to realize new business opportunities, as well as pro-actively adapt to the emerging demands and pressures from various stakeholders (Korhonen et al., 2015). Again, the FOAs have important roles as knowledge hubs and as links between forest owners, contractors and society. The increasing focus on the environmental and social sustainability of business activities requires the responsibility of producers (Toppinen et al., 2013), which, for harvesting services, translates directly into corporate responsibilities for the service selling FOAs as well as their service providing contractors. FOAs should embrace the different goals, concerns and forest management requests of forest owners when considering social aspects and conserving biodiversity, as this attitude will act as a driving force for increased diversity. Findings from Eggers et al. (2015) support this claim, as their results indicated that the forest holdings of Swedish NIPF owners generally produce larger biodiversity than other owner categories with larger forest holdings, which has been shown also in other countries. This stemmed from the diverse management strategies employed by forest owners that also generally translate into higher growing stocks and thus, increased carbon storage capacity. As forest owners pay for the services *themselves* and account for the potentially increased costs of suboptimal forest operations (from the economic aspect) that deviate from standard recommendations, the profitability of FOAs are consequently far less affected by diversified management compared to that of forest actors who hold large own forest assets and whose profits are directly connected to costs and outcomes of

forest operations. Thus, the forest owners, from a societal perspective, play an important role in service development as *diversifiers* of forest management. While FOAs carry the main responsibility for service development, contractors still have a large responsibility as well; as service performers, they must ensure large consideration to environmental and social values during operations and leave behind undamaged harvesting sites, soils and roads that visually communicate care and responsible practice towards the public. Contractors are also *facilitators* in the operational implementations of new services and the required technology, and FOAs should embrace the potential for contractors to act as *innovators* of services. FOAs cannot neglect the importance of using local know-how and capabilities (Schmid et al., 2012), which applies not only to contractors, but also to knowledgeable forest owners. The primary current needs from each perspective of the service triad identified using the research underlying this thesis are summarized in Table 4, along with the different roles and responsibilities of each group in service development.

Table 4. *The primary current needs from each perspective of the service triad along with the roles and responsibilities of the different groups in service development*

Perspective/ Group	Identified current needs	Roles and responsibilities in service development
FOAs	Tailoring of business models to fit local industrial contexts Evaluation and tailoring of current follow-up models (and performance indicators) to reflect the most important service values in individual service triads Translation of service values to monetary terms for better evaluation of performances and refined pricing of customized services Ensuring satisfaction of highly valued contractors Development of routines to formalize direct agreements between forest owners and contractors Identifying future needs for service (and product) development	Knowledge hubs Drivers for service (and product) development in order to adapt to forest owners' and society's demands Large responsibilities for increasing attractiveness of forest work
Contractors	Improved conditions for increased satisfaction and profitability Tailoring of contract parameters to reflect individual needs Pricing of services reflecting involved risks and values of performances	Facilitators for service development Large responsibilities for upholding and increasing a positive image of forestry to the public Innovators of services
Forest owners	Development of objective tools to evaluate performances Differentiation of service offers with defined costs vs outcomes	Ensuring diversity in forest management Contributors of innovative ideas

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