Managing timber procurement in Nordic purchasing sawmills

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Abstract


Procurement of sawlogs to purchasing sawmills represents a basic strategic business process. The properties of inbound sawlogs are decisive for the output of sawn products and the cost of raw material contributes substantially to the cost of the final product. Increasing customer orientation and new demands from powerful customers in the building and retail sectors entail new or accentuated demands on management of procurement. Managing raw material procurement and communicating needs to suppliers and logging machine operators are vital issues for sawmills in order to be competitive.

The purpose of the thesis is to explore how purchasing sawmills manage procurement of sawlogs. The results are based on 46 in-depth interviews with people involved in the procurement process at seven softwood sawmills in Denmark, Finland and Sweden. The thesis identifies various types of supply uncertainties as well as process improvement and buffer activities that reduce uncertainties. However, the major obstacle in the procurement process is the power/dependence balance in the relationships with suppliers. Beyond doubt, it restricts the manageability of procurement and particularly bucking. The results suggest that there are a number of ways to improve management of procurement, which are currently not fully employed. The thesis provides four key strategic dimensions of the procurement process and suggests a general conceptual model of wood procurement to purchasing sawmills.

Further research within the subject can usefully explore the link between procurement management and procurement strategy as well as the relation to other functions' strategies and the corporate strategy. The importance of the identified strategic dimensions of the procurement process needs to be quantified in order to provide normative suggestions.

Keywords: Procurement management, Sawmill industry, Supply uncertainties, Buyer-supplier relationships, Bucking, Contractual forms, Strategy, Case Studies
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Växjö, August 2006

Klara Helstad
List of papers

This thesis is based on research reported in four papers, which are attached at the end of the thesis. The papers are referred to by roman numerals and ordered with the intention to make it easier to follow the logic of the thesis. Paper I was written in co-operation with Prof. Rolf Björheden. The International Journal of Forest Engineering is greatly acknowledged for the permission to publish paper I.


Table of contents

1 INTRODUCTION ........................................................................................................... 7
  1.1 Background............................................................................................................. 7
  1.2 Purpose, research questions and delimitations ................................................... 9
2 PROCUREMENT AND PURCHASING MANAGEMENT ........................................ 12
  2.1 Elements of procurement and purchasing management........................................ 13
    2.1.1 Strategic thinking in procurement management ........................................... 13
    2.1.2 The procurement and purchasing process ..................................................... 15
    2.1.3 Managing buyer-supplier relationships ....................................................... 18
3 PREVIOUS RESEARCH ON WOOD PROCUREMENT .................................... 20
  3.1 Purchasing and suppliers.................................................................................... 23
  3.2 Optimisation of logging and transport operations .............................................. 24
4 STRATEGY RESEARCH IN THE SAWMILL INDUSTRY ................................ 26
5 METHODOLOGY ...................................................................................................... 28
  5.1 Methodological approach.................................................................................... 28
  5.2 Research process................................................................................................ 28
  5.3 Evaluation and analysis of cases ........................................................................ 32
  5.4 Quality of conclusions ....................................................................................... 33
6 PRESENTATION OF THE INCLUDED PAPERS ........................................... 35
  6.1 Raw Material Procurement in Sawmills' Business Level Strategy - A Contingency Perspective ..................................................................................... 36
  6.2 Managing supply uncertainties in procurement of sawlogs for sawmills ............. 37
  6.3 Supplier relationships - a strategic element of sawmills' timber procurement management ................................................................. 38
  6.4 Information exchange and management of bucking to improve precision in sawmills' raw material procurement ..................................................... 38
7 DISCUSSION .............................................................................................................. 40
  7.1 The procurement process .................................................................................... 40
  7.2 Procurement's implications on sawmills' strategies ............................................ 44
8 CONCLUSIONS ........................................................................................................ 46
  8.1 Managerial implications ..................................................................................... 47
  8.2 Suggestions for further research ........................................................................ 48
REFERENCES ............................................................................................................. 49
1 Introduction

1.1 Background

Procurement to sawmills is a complex process that comprises purchasing, logging, transportation, as well as planning and management of these activities. Procurement represents a basic strategic business process since the properties of inbound sawlogs are decisive for the output of sawn products and, for Swedish sawmills, the cost of raw material contribute around 2/3 of the final product cost (Bergqvist et al. 1988; Gustafsson 2006). The need for improving management of procurement has increased as a result of intensified competition and extensive new demands from powerful customers in the building and retail sectors. The formerly fairly strict division between actors in the supply chain is loosening due to increased vertical integration and value-adding activities (Nord 2005). There is a need to provide different types of logistic services to the customers (Gustafsson 2006) as sawn wood products are typically of commodity type (Roos et al. 2002), even though sawmills increasingly produce value-added products (Staland et al. 2002). The customers’ demands need to be met by the sawmills. However, one impediment is that sawlogs are processed in a divergent material flow where the output from sawmills consists of a wide variety of requested and non-requested products; each requested product entailing consequential products. This implies that dimensions with low attractiveness on the market could be produced, a problem that increases if incoming sawlogs are not cut to meet the market and order situation for sawn products. The complexities of the procurement process restrict management of procurement due to impediments such as the heterogeneous raw material, the fragmented supplier structure and the characteristics of suppliers, the dependence on local supply, and the keen competition on the raw material market. These impediments will shortly be outlined in the introduction and thereafter further described and explored later in the thesis and in the included papers.

This thesis focuses on purchasing sawmills, i.e. privately owned sawmills that rely to a large extent on local supply from external sources. Only small quantities of raw material can be transported from remote areas due to cost and quality reasons. Principally, there are six major origins of timber to satisfy the sawmills’ need of raw material, even though there are differences between countries:

- timber harvested in own forest (usually only possible for marginal amounts),
- timber traded with other sawmills or forest companies,
- imports,
- delivery timber,
- standing timber for sale (stumpage purchase),
- and cutting commissions.

Purchasing of stands is the first step and constraint in the procurement process. In the Nordic countries and for instance in the USA, purchasing sawmills are usually dependent on multiple suppliers, mainly Non-Industrial Private Forest owners (NIPF). The fragmented supplier structure means that a single sawmill may annually procure and harvest thousands of individual stands (Harstela 1997). The forest owners’ decision-making situation is such that their behaviour resembles that of a customer more than of a supplier (Larson and Hardie 1989; Rosen et al. 1989; Sikanen 1999). The result is keen competition on the sawlog market. Kärhä (1998) showed that the willingness of the forest owners to sell timber is one of the major constraints influencing the procurement managers’ decision-making. Research on purchasing and suppliers and their characteristics is further described in chapter 3.1.

Sawlogs is a heterogeneous raw material, which implies that it cannot be manufactured to a particular specification; instead, it is possible to select logs with the most desirable range of properties (Dinwoodie 2000). Most wood quality parameters and potential dimensions vary both within procurement regions, forest stands and the individual tree. As a result, the final properties of the procured sawlogs are partly, but not fully, dependent on a number of choices made by the sawmills’ procurement department: species composition, lengths, and to some extent, diameters of the procured sawlogs etc. The managerial task with respect to procurement management is to pursue a set of choices that will optimise the incoming stream of sawlogs in a given market situation with respect to the sawmills production technology, internal stocks and current stock of orders. Thus, a large part of the production process is spent on homogenising the production into batches based on tree species, dimension and quality parameters. The poor data regarding properties of sawlog implies problems for the procurement and production departments since the flow of wood might not match the expectations.

![Figure 1. Demand affects purchasing and harvesting instructions including bucking matrixes](image_url)
In the Nordic countries, the shortwood method (Cut-To-Length method) has a predominant position compared with the tree-length method where bucking is postponed as far as to the sawmill. The introductions of one-grip harvesters in the 1980s together with development of Information and Communication Technology (ICT), Global Positioning System (GPS), Geographical Information System (GIS) and decision support systems have made it possible to improve the final stages of the procurement process. Harvesters are increasingly equipped with satellite, cellular or wireless data communication for receiving instructions, price matrix files and maps. After cutting, log-tallies may be transmitted to the sawmill, i.e. a matrix of the volume and number of logs for different length and diameter combinations. The augmented requirements from customers, decreasing stock levels in the supply chain, and need for continuous increased productivity requires improved integration within the supply chain. Sales forecasts and stock of orders allow sawmills to manage purchasing of raw material, distribute the logging of stands over time and manage bucking for each stand (Figure 1). Accurate bucking of logs against specifications and customers' demands would lead to improvements and rationalisations of the following processes. The raw material dimensions and quantities, bucking and sawn wood production are strongly interrelated where the bucking decision determines the degree of freedom in later production steps. However, bucking flexibility is dependent on applied contractual form, which is described and explored in paper IV.

1.2 Purpose, research questions and delimitations

The sawmill industry is influenced by a changing competitive environment and over-capacity that leads to further concentration of the industry and its customers. The concentration of purchasing power implies that the customers take control, changing the balance of power in the distribution channel. Increased demands on product quality, lead-times and stock levels cause higher demands on the sawmills. Meanwhile, the sawmill industry is consolidating (Nilsson 2001; Staland et al. 2002; Nord 2005) and new multi-mill combines open up opportunities for sawmills to position themselves strategically in the competitive environment for marketing and procurement. However, the special characteristics of the raw material and the suppliers together with the keen competition on the raw material market obstruct procurement management and limit the sawmills' degree of freedom. The challenge is to increase the manageability of procurement despite such external and internal obstacles.

This study applies a broad definition of procurement, as proposed by Novack and Simco (1991):

"Procurement consists of all those activities necessary to acquire goods and services consistent with user requirements."
According to van Weele (1994) and Leenders and Fearon (1997), the term procurement is somewhat broader than purchasing. Procurement includes all activities required in order to get the product from the supplier to its final destination, such as purchasing, storing, receiving, incoming inspection and salvage, while purchasing describes the process of buying. Procurement and purchasing have received a lot of attention by researchers and are further explored in chapter 2 and 3. Cox (1996) criticised the research within the procurement discipline and argued that the scientific works have not explained under which conditions and for what circumstances different practices were replicable across dissimilar industries and companies. A literature survey on wood procurement (chapter 3) indicates that research is lacking on how purchasing sawmills manage raw material procurement. Nevertheless, general theory on procurement and purchasing could give valuable input on, for example, the procurement process and buyer-supplier relationships.

The general research question is:

*From a purchasing sawmills’ perspective, what are the main uncertainties of raw material procurement, how is procurement organised and how can the manageability of raw material procurement be improved?*

The general research question could be divided into a number of explorative sub-questions:

- How do sawmills work to reduce supply uncertainties?
- How do sawmills manage supplier relationships?
- How do sawmills communicate their need of sawlogs to suppliers and contractors?
- How can sawmills manage and control procurement through management of bucking?

The following assumption was made:

The basis for this study is that sawmills’ procurement process highly influences the sawmills’ possibilities to effectively satisfy customers’ needs. The procurement management is dependent on characteristics of the sawmill and its context, such as market approach, production size, organisation, and supply market.

The purpose of the thesis is to explore how purchasing sawmills manage procurement of sawlogs. A general model of the procurement process is developed and serves as an explorative tool. The objective is to obtain a deeper knowledge of how sawmills manage procurement under the particular conditions of purchasing sawmills.

The thesis is limited to purchasing sawmills in Denmark, Finland and southern Sweden. The reason for studying purchasing sawmills is that they have a very
limited, if any, supply from own forests and are independent of other business interests in comparison to forest industries or forest owners’ associations that own pulp and/or paper mills. Only purchasing sawmills that produce softwood products will be studied since hardwood production is only marginal in the Nordic countries.

The thesis is composed of eight chapters, whereof this chapter has described the background to the study, the research questions, purpose and delimitations. In the next chapter the theoretical base is presented, i.e. procurement and purchasing management in general. In chapter 3, theory on wood procurement and its sub-activities is put forward. Chapter 4 deals with strategy research in the sawmill industry, while chapter 5 concentrates on the methodology, the research process, and the data analysis. The included papers are introduced in chapter 6 and thereafter discussed in chapter 7. In chapter 8, the conclusions from the study are drawn.
2 Procurement and purchasing management

This research is focused on procurement and purchasing management and this chapter provides the theoretical framework for the study. The activities taking place in the procurement process are dependent on the product type. Thus, the manufacturing processes can be characterised according to the following categories which explain why procurement activities differs considerably between companies and industries (van Weele 1994):

- **Make to stock**: Standard products are manufactured and stocked based on sales forecasts
- **Make to order**: Products are manufactured from raw material or purchased components in inventory after a customer order has been received and accepted
- **Engineer to order**: All manufacturing activities from design to assembly including purchasing of required materials are related to a specific customer order

In this thesis, the first two categories of processes are of interest. Kraljic (1983) pointed at a necessary change of perspective: from purchasing as an operational function to supply management as a strategic one. In the 1990s, many authors called for purchasing to become more strategic (see e.g. Gadde and Håkansson 1993; Saunders 1994; van Weele 1994; Leenders and Fearon 1997). Today, the strategic character of supply management has largely been recognised, even though few authors have discussed the link between supply strategy and the strategy of the firm (Nollet et al. 2005). Nevertheless, the purchasing function could play a key role in developing and employing a strategy leading to sharpened efficiency and increased competitiveness (Leenders and Fearon 1997). Axelsson and Håkansson (1984) distinguished three strategic roles in purchasing; the rationalisation role, the developmental role and the structural role, where the rationalisation role includes all the operative activities performed to reduce costs. The developmental role aims at increasing involvement in suppliers' development works, while the structural role is defined as the way in which companies affect the structure of the supply market e.g. concentration of purchasing to one supplier or alternatively, maintain a number of alternative suppliers. The industrial system as a whole is characterised by increasing specialisation, which has lead to a growing importance of purchasing (Gadde and Håkansson 1993). A traditional view of effective purchasing is the minimising of price by playing different suppliers off against each other (Gadde and Håkansson 1993). However, purchasing methods are changing as well as relations to
suppliers (Gadde and Håkansson 1993). The interchangeability of suppliers has decreased as a result of the increased specialisation (Gadde and Håkansson 1993). Cox (1996) criticised the research within the procurement field and characterised it as "pre-scientific" having an atheoretical approach. His main arguments were that the scientific works have not explained under which conditions and for what circumstances different practices were replicable across dissimilar industries and companies.

The elements of procurement and purchasing are discussed in the following subsections.

### 2.1 Elements of procurement and purchasing management

Van Weele (1994) described the purchasing management process as: purchasing market research, determining purchasing objectives and strategy, action planning, policy implementation, and control and evaluation. In this sub-section, some important research are summarised on elements of the procurement and purchasing management such as strategy, process, and buyer-supplier relationships.

#### 2.1.1 Strategic thinking in procurement management

Adequate and timely supply is critical to most companies. However, van Weele (1994) claimed that clear guidelines for setting up a purchasing strategy are difficult to find. Due to the lengthy theoretical and practical debates on strategy it is not surprising that a clear definition and formulation of supply strategy is hard to get accepted (Nollet et al. 2005). Lambert et al. (1998) suggested that the strategic role of purchasing is to perform supply-related activities in a way that supports the overall objectives of the organisation. Thus, a supply strategy is preferably framed and crafted following corporate and business strategies as well as consolidated with other functional strategies (Nollet et al. 2005). Nollet et al. (2005) described the evolution of the thinking about the strategic role of supply (Figure 2). According to Ellram and Carr (1994) and Ramsay (2001), the first attempts to raise purchasing function's strategic role were made in the mid-1970s. Corey (1978) argued that procurement strategies vary greatly depending on purchasing situation and thus, every strategy has to be tailored.

Watts et al. (1992) made the connection between corporate strategy, purchasing and other functional strategies explicit in a conceptual framework. Ellram and Carr (1994) identified three types of purchasing strategy: (1) specific strategies employed by the purchasing function, (2) purchasing's role in supporting overall strategies and other functions' strategies, and (3) the utilisation of purchasing as a strategic function of the company. Carr and Smeltzer (1997) distinguished purchasing strategy from strategic purchasing where a purchasing strategy
relates to the specific actions that the purchasing function may take to achieve its objectives while strategic purchasing refers to the planning process purchasing follows as part of the strategic management process. Carr and Smeltzer developed four indicators including underlying variables that correlate to the level of strategic purchasing: (1) status (other function's and top management's view of the purchasing function), (2) knowledge and skills (knowledge of supplier markets, analytical skill and purchasing performance measurement), (3) risk (willingness to take advantage of new opportunities, foresight), and (4) resources (purchasing's access to information and use of information technology).

Cox (1996) emphasised the importance of strategic procurement management and distinguished it from the reactive and traditional purchasing and supply management. Proactive procurement and purchasing have also been discussed by for instance Carr (1996), Burt and Pinkerton (1996) Lambert et al. (1998) and Smeltzer and Siferd (1998). Carr defined proactive purchasing, as purchasing's willingness to take risks and to effectively use current knowledge to make decisions about the future. Forward buying could also protect the company from anticipated shortages or delay the impact of rising prices.

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General market influences will affect both parties in any transaction and thus, will have an impact on the procurement process (Novack and Simco 1991). Buvik (2001) emphasised the identification and analysis of market structures as a base for purchasing decisions. The purchasing portfolio technique developed by Kraljic (1983) is an approach where the purchasing product assortment is analysed on the basis of two types of variables: the importance of purchasing to the company and the supply risk. These variables give a matrix where each quadrant represents a product group and a purchasing policy (Figure 3). Thus, the purchasing strategy will differ depending on the place of a specific item within the portfolio. This could for example be an aggressive, a defensive, or a balanced strategy (van Weele 1994). Further research on portfolio models in purchasing includes Turnbull (1990), Olsen and Ellram (1997a), Bensaou (1999), and Nellore and Söderquist (2000). Portfolio models in strategic planning have been criticised, but they can be useful to organise information and classify suppliers (Olsen and Ellram 1997a; Nellore and Söderquist 2000).
Nollet et al. (2005) provided a conceptual framework for supply strategy formulation by segmenting supply management decisions. Cousins (2005) argued that the perception of the strategic nature of supply depends on the company's strategic goals and priorities. The results suggest that a company that adopts a cost focused approach to its competitive position, will unlikely consider supply as a strategic process. Whereas companies viewing their competitive advantage as being differentiated will see supply as strategic.

### 2.1.2 The procurement and purchasing process

In the following section a review of some of the numerous studies of the procurement and purchasing process are presented. The section concludes in a theoretical framework based on the reviewed studies.

Most researchers have attempted to model the purchasing process in a number of chronological phases or stages. Robinson et al. (1967) developed the Buygrid Framework for analysing buying situations with the aim to be applicable to buying organisations of all kinds and sizes. The framework consists of eight-stage model (buyphases) of the purchasing process:

1. Anticipation or recognition of a problem (need) and a general solution
2. Determination of characteristics and quantity of needed item
3. Description of characteristics and quantity of needed item
4. Search and qualification of potential sources
5. Acquisition and analysis of proposals
6. Evaluation of proposals and selection of supplier(s)
7. Selection of an order routine
8. Performance feedback and evaluation

The eight buyphases are combined with three types of purchase situations: new-task, modified rebuy, and straight rebuy. A specific buying situation is placed in
the correspondent buyclass depending on: (1) the newness of the problem, (2) the information requirements, and (3) the consideration of new alternatives. The Buygrid Framework has been adopted as an analytical tool by many researchers even though it has been criticised by for instance Webster and Wind (1972a) and Johnston and Spekman (1982). Webster and Wind (1972a) suggested a five stages organisational buying decision process model:
1. Identification of need
2. Establishing objectives and specifications
3. Identifying buying alternatives
4. Evaluating alternative buying actions
5. Selecting the supplier

Each of the stages in the process could be more or less distinct, some stages may be repeated, and the process may also leap between the stages. Furthermore, the authors stated that after the supplier has been chosen, a variety of decisions may be required to maintain and administer the buyer-supplier relationship.

Håkansson and Wootz (1975) described the purchasing process and investigated supplier selection behaviour. Wind and Thomas (1980) provided a conceptual structure of Organisational Buying Behaviour (OBB), which consist of three major concepts: the buying process, the buying center and factors affecting these (Table 1).

Table 1. Major concepts of Organisational Buying Behaviour (Wind and Thomas 1980)

<table>
<thead>
<tr>
<th>Buying Process (BP)</th>
<th>Buying Center (BC)</th>
<th>Factors affecting BP and BC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall buying process</td>
<td>Identifying the composition of the BC</td>
<td>Buying situation (BP)</td>
</tr>
<tr>
<td>Identification of needs</td>
<td>Roles in the BC</td>
<td>Personal (BC)</td>
</tr>
<tr>
<td>Identification of alternatives</td>
<td>Influence in the BC</td>
<td>Interpersonal (BC)</td>
</tr>
<tr>
<td>Set purchase and usage criteria</td>
<td></td>
<td>Organisational (BC)</td>
</tr>
<tr>
<td>Evaluate alternative</td>
<td></td>
<td>Inter-organisational (BC)</td>
</tr>
<tr>
<td>buying actions</td>
<td></td>
<td>Environmental (BC)</td>
</tr>
<tr>
<td>Purchase decisions</td>
<td></td>
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<tr>
<td>Post purchase evaluation</td>
<td></td>
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</tr>
</tbody>
</table>

Novack and Simco (1991) described the procurement process, i.e. the adherent activities as follows:
1. Identify or reevaluate needs
2. Define and evaluate user requirements
3. Decide to make or buy
4. Identify type of purchase
5. Conduct market analysis
6. Identify all possible suppliers
7. Prescreen all possible sources
8. Evaluate remaining supplier base
9. Choose supplier
10. Deliver product/performance service
11. Postpurchase/make performance evaluation

The procurement activities are subject to environmental influences affecting the process beyond the control of the procurement staff. Novack and Simco utilised a framework developed by Busch and Houston (1985) to describe the characteristics of the environmental influences, i.e. individual factors, intraorganisational factors, interorganisational influences, and external influence.

Gadde and Håkansson (1993) identified three factors that affect the internal workings of the purchasing company: the technological and organisational structure of the company, and the knowledge and attitude of the personnel with regard to purchasing. Webster and Wind (1972b) proposed five different roles performed by buyer center participants:

- Users; who actually use the purchased product
- Deciders; who select the vendor or supplier of the product
- Influencers; who add information or decision criteria to the decision process
- Buyers; who execute the contractual arrangements
- Gatekeepers; who control the flow of information into the buying center

Pettigrew (1975) studied the flow of information during a purchase process and observed the importance of individuals controlling the information flow (gatekeepers). Those gatekeepers heavily influenced the outcome of the purchase through structuring the information flow. Bonoma (1982) further developed Webster and Wind’s (1972b) theory on the buying center. The roles defined by Bonoma were: initiators, deciders, influencers, purchasers, gatekeepers, and users. Recent research on roles includes Knight and Harland (2005) who derived six supply network management roles using constructs from role theory. According to them, an actor in a network can be viewed as a set of roles. Roles can be seen as context specific and negotiated between the role enactor and role senders.

Applying the theories presented in the sub-section the following conceptual model of the procurement process (Figure 4) emerges as a theoretical framework for the study. Environmental influences and factors that affect the procurement process are included.
2.1.3 Managing buyer-supplier relationships

Buyer-supplier relationships have received considerable attention in purchasing and marketing literature. In the classical view of purchasing the buyer has the upper hand and gains two things by playing different suppliers off against one another (Gadde and Håkansson 1993):

1. Lower price. The competition leads the suppliers to work more effectively and thus reduce their costs.
2. Avoidance of over-dependence on a single supplier.

According to Olsen and Ellram (1997b) the marketing literature is often based on the transaction cost approach and directed towards theory development and testing with focus on micro aspects of relationships. The purchasing literature, on the other hand, is often focused on the practical use of research findings and thus, the general reasons for relationship formation and reports on actual results in companies. The third group of research emanates from the International Marketing and Purchasing Group (IMP Group) that has developed and expanded a model of industrial buyer-supplier relationship and put it in a network context. The model describes relationships both on a macro and a micro level. Olsen and Ellram (1997b) identified three recurring research themes in buyer-supplier relationships: (1) characteristics and benefits of buyer-supplier relationships, (2) establishment and development of buyer-supplier relationships, and (3) managing buyer-supplier relationships. In order to manage relationships, Spekman and Johnston (1986) suggested that the extent of control is an important factor. Emerson (1962) developed a theory of power relations and suggested strategies for changing power-dependence structure and balancing operations from the buyer's point of view. Trust and relational contracts based on norms and collective interests have been explored by e.g. Heide and John (1992); Doney and Cannon (1997); Smeltzer (1997); Rousseau et al. (1998). Hines (1994) and Macbeth and Ferguson (1994) advocated building partnership with suppliers as a strategic sourcing option inspired by Japanese companies. Cox (1996), on the other hand, argued that there is a tendency amongst some researchers that there is a best type of external relationship such as partnerships.

Figure 4. The procurement process - environmental influences and factors. Theoretical framework developed based on the literature review
and networks instead of outlining the most significant variables shaping the relative utility of particular relationships in discrete business contexts. Olsen and Ellram (1997b) brought up similar opinions and argued that close relationships and their benefits are overemphasised in purchasing literature. A number of articles provide normative suggestions for management of buyer-supplier relationships such as Kraljic (1983). Olsen and Ellram (1997a) developed the portfolio models of Kraljic (1983) and Fiocca (1982) further and suggested a three-step approach to analyse and manage a company's supplier relationships:

- **Analysis of the company's purchases to find ideal relationship types for major purchases:** The strategic importance of the purchase describes factors internal to the firm such as competence, economic and image factors. The difficulty of managing the purchase situation describes factors external to the firm such as product, supply market and environmental characteristics.
- **Analyse the supplier relationships:** Determine the way the supply task is managed in the company. The supplier relationships associated with the purchases are categorised based on relative supplier attractiveness and the strength of the relationship between the buyer and the supplier.
- **Develop action plans:** Describe how to adapt the existing supplier relationships by comparing the ideal situation (1) to the actual supplier relationship (2).

In paper III, the model by Olsen and Ellram (1997a) is partly applied in order to explore buyer-supplier relationships in two case companies. Earlier research on buyer-supplier relationships in wood procurement are summarised in the following chapter.
3 Previous research on wood procurement

Hakkila (1995) stated that wood procurement consists of: purchasing, cutting, off-road transport from stump to roadside, measurement and secondary transport from roadside to mill, while Harstela (1997) also included the management of these activities. Keipi (1978) described the wood procurement problem and explored alternative approaches of decentralised wood procurement planning. The wood procurement functions and the process as described by Keipi are shown in Figure 5. Harstela (1993) also described wood procurement as a process, furthermore, he included the supplementary systems required for steering and controlling the process (Figure 6). The figure shows the hierarchical levels but excludes the interactions between the different elements.

Figure 5. Wood procurement functions described by Keipi (1978)

Wood procurement has mainly been studied as a planning problem (Harstela 1993) with focus on large forest companies. Generally these contributions have applied various Operations Research tools e.g. simulation, optimisation and decision support (see e.g. Keipi 1978; Asikainen 1995; Palander 1998; Carlsson & Rönnqvist 1999; Sikanen 1999; Schreiber 2004). Wood procurement has also been studied by methods of economics or focused on technical performance of machines or systems. Some recent research has applied a broader perspective on
wood procurement as a part of the integrated forestry-wood chain (see e.g. Adolfson et al. 2000; Fjeld 2001; Lidén and Rönnqvist 2001; Usenius 2002; Uusijärvi 2003). Even though many kinds of decision support systems have been suggested, few of them meet the real needs of team managers in the group decision-making process (Palander et al. 2002).

Figure 6. Wood procurement and its supplementary systems (Harstela 1993)

According to Uusitalo (2005), the main customer service goals in wood procurement are price, dimensional requirements, quality requirements and the ability to react to changes. Harstela (1997) suggested that wood procurement often includes modern, rather flat organisations with decentralised decision making and management by objectives. The operational planning at a forest company could concisely be described as the methods of selecting the available stands, distributing harvesting of the stands over time and allocating the stands to the harvesting teams. Input information to the operational planning consists of stand register and follow-up data, maps and data on available harvesting teams and the demand. This approach presupposes that the company has a stand inventory and can select between stands. Kärhä (1998) indicated that procurement managers experience that the decision-making environment is in a constant flux and this was regarded to be the most serious problem affecting decision-making. The managers also gave a list of the major constraints influencing the decision-making: used capacities of mills, the willingness of forest owners to sell timber, forest resources in their procurement area,
harvesting conditions, the availability of forest machines and trucks, speed required in decision-making as well as close and inflexible goals (Kärhä 1998).

Figure 7. Main steps of simulation model of the timber procurement process and the attributes affecting it (adapted from Sikanen 1999)

Sikanen (1999) developed a discrete event simulation model for purchasing of marked stands, harvesting and transportation (Figure 7). The model consists of a stand generator, purchasing of stand, a tree generator, and logging-, forwarding- and transportation models. However, Sikanen found the model not to be very useful for research purposes. Palander et al. (2005) designed a group decision-making model in order to enhance the timber procurement planning process. The model was tested on a forest company during three months and the participants thought that co-operation between local and district-level teams had improved. Furthermore, the productivity increased thanks to the reduction in average length of planning stages. Uusitalo (2005) suggested a general framework for the shortwood method-based wood procurement and pointed out important issues for the future: release of current wood trade systems, accurate information about stand properties, and better terrain classification systems.

To summarise, wood procurement has mainly been studied from a forest company perspective. Specific research on sawmill's procurement process is lacking. In sub-section 3.1 and 3.2, the reader is provided with literature reviews on purchasing and suppliers as well as optimisation of logging and transport operations.
3.1 Purchasing and suppliers

Timber purchasing has been studied for instance to predict available quantities in the market (Hahtola et al. 1973; Tervo 1978; Kuuluvainen et al. 1984; Järveläinen 1988; Lönnstedt 1989) and tax regulation’s influence on purchasing (Larsson 1983; Aronsson 1990). A few studies on purchasing strategies have been performed (e.g. Uhrdin 1989; Johansson 1990; Tervo 2004), however, they do not provide any model of purchasing strategy and its elements or how the purchasing strategy is related to the procurement strategy and other functions’ strategies.

Uhrdin (1989) found that trust between buyer and seller combined with the price were the most important factors influencing purchasing. Further, previous transactions increase the probability of recurring business between buyers and suppliers (Sikanen 1999). Offering different services and good and fast work could develop the relationships (Uhrdin 1989). Sikanen (1999) suggested that a timber purchase is either a new task or a modified rebuy since the stand is always new, while the seller can be an old acquaintance (referring to the Buygrid model by Robinson et al. 1967). Tervo (2004) compared small and medium-sized sawmills to the buying units of integrated forest companies. It was found that roundwood buyers of integrated companies were more customer (i.e. seller) and service orientated, compared to small and medium-sized sawmills that focused more on costs and roundwood criteria.

Previous studies on NIPF behaviour is extensive, focusing primarily on how harvesting decisions of NIPF are related to different factors (Conway et al. 2003). Behaviour of sellers and buyers, their relationships, the decision-making environment, and principles applied by sellers have been studied by for instance, Larson and Hardie (1989), Rosen et al. (1989), Lönnstedt and Törnqvist (1990), Hardie and Larson (1994), Kuuluvainen et al. (1996), Kärhä and Oinas (1998), Karppinen (1998), Sikanen (1999), and Conway et al. (2003). However, no consistent model has been used and different theories have been applied as a basis for describing the forest owners’ objectives (Hugosson and Ingemarson 2004). Amacher et al. (2003) provided a review on econometric studies of how NIPF make decisions. Kuuluvainen et al. (1996) and Karppinen (1998) found that forest owners’ cutting behaviour were dependent on ownership characteristics and objectives. Multi-objective owners were the most active in their silvicultural and cutting behaviour. According to Lönnstedt and Törnqvist (1990) the price level is the most important factor influencing NIPF cutting decisions while the action plan in the forest management plan is most important in the long term. The cutting decision is also based on the forest owners’ forestry strategies, activity level, income, tax, lack of time etc. The incentives to harvest are influenced by both business specific and external factors. Hugosson and Ingemarson (2004) reported that professional foresters interpret a change among NIPF towards conservational interests.
3.2 Optimisation of logging and transport operations

In the Nordic countries, bucking and transport operations are considered as separate processes, however, Uusitalo (2005) suggested that these tasks should not be considered as separate, but instead be optimised as a whole. Thus, it would be possible to optimise which products in what quantities may be cut from each stand without increasing loading and transport operations. Previous research on how bucking could be developed to respond to customer demand have often focused on technical aspects, comparison of systems or optimisation (see e.g. Näsberg 1985; Epstein et al. 1999; Kivinen 2004; Malinen and Palander 2004; Uusitalo et al. 2004; Kivinen et al. 2005). Models have been developed for harvesting and bucking problems where most of them are linear or dynamic programming models (Uusitalo 2005). However, some research has focused on developing systems for integration of sawmill's production planning and bucking. Maness (1989) linked determination of optimal bucking with sawing policies in a common model for sawmills where bucking is performed at the sawmill. Reinders (1993) designed a decision support system to support production planning including bucking at a sawmill. Lidén and Rönnqvist (2001) propose a system to be used for tactical planning of bucking, sawing and planing in order to work more customer-oriented. Todoroki and Rönnqvist (2001) reported on a prototype system that is implemented in the AUTOSAW log sawing simulation system. The product optimisation system dynamically controls production to fulfil orders by feedback from regularly updated production tallies. The result was that fewer logs were required to satisfy orders and over-production of unordered products was significantly reduced.

The cost of transportation represents one third of the total cost of raw material to the forest industry (Forsberg et al. 2005). Extensive research has addressed the field, often applying Operations Research. Today, the transport planning, at least in Sweden, is decentralised and manual to a high degree (Forsberg et al. 2005). Haulage contractors mainly perform the haulage from forest to sawmill. It is of importance to manage the haulage for several reasons e.g. the possibilities to give precedence to certain tree-species, lengths, diameters or qualities but also to reduce inventories. In the daily operational planning of haulage, there are, in principle, two different problem areas (Carlsson and Rönnqvist 1999): the planning problem and the dispatch problem. In planning, trips or trip sequences are generated based on estimates of supply and demand for all vehicles the following day (Carlsson and Rönnqvist 1999). The dispatch problem deals with the construction of trips or trip sequences in real-time, based on accurate information about the current situation (Carlsson and Rönnqvist 1999).

The problem of scheduling is complex and fraught with constraints (see e.g. Karanta et al. 2000). Large forest companies have generally planned and carried out wood procurement independently. However, in Sweden there is co-operation among several companies and organisations to combine overall transports and
thus, decrease transport distances and costs (Carlsson and Rönnqvist 1999; Forsberg 2003; Forsberg et al. 2005; Palander and Väätäinen 2005). However, co-operation between companies could be difficult, as they do not want to reveal supply, demand and cost information (Forsberg et al. 2005) Thus, wood bartering of specific volumes is done. Improved transport optimisation and inventory booking systems have led to decreased stock levels (Bergdahl et al. 2003).

Different systems for haulage co-ordination have been developed for timber transport but there are only few systems in use. Several studies have shown that costs can decrease between 2-20% by using back-haulage tours (Carlsson and Rönnqvist 1998; Bergdahl et al. 2003; Forsberg 2003; Palander and Väätäinen 2005), however one obstacle is the huge increase in variables due to the potential routes (Forsberg et al. 2005). Walter and Carlsson (1998) described a prototype system for haulage co-ordination where all communication takes place via the Internet. Weintraub et al. (1996) described an operative and computerised system to support daily truck scheduling decisions based on a simulation process with heuristic rules. Palmgren (2001) proposed a mathematical model of the log truck-scheduling problem based on a set partitioning type problem. Forsberg et al. (2005) presented a decision support system for strategic and tactical transportation planning (FlowOpt) based on data from two case studies.
4 Strategy research in the sawmill industry

Traditionally, sawmill strategies have been cost orientated, aiming to reduce unit costs by seeking scale and price advantages to increase productivity. Previous research reported in this thesis, has focused on the strategic role of procurement and its connection to corporate strategy and other functional strategies. There have been a number of research efforts within the strategy field in the sawmill industry. However, there are only a limited number of studies made concerning purchasing strategies and research on strategic procurement is lacking (see also previous chapter).

Juslin and Tarkkanen (1987) defined the marketing strategy concept where marketing strategy refers to the company’s relationship with its environment and is determined by making decisions concerning products, customers, market areas and marketing competencies. The results indicated that the Finnish sawmill industry is based on commodity product strategy. However, less than half of the medium-sized sawmills applied a commodity product strategy, while this strategy represented about 70 per cent of the large and small sawmills' product strategy. Juslin and Tarkkanen (1987) argued that this difference could be due to that medium-sized sawmills have greater flexibility than larger sawmills and they have more resources than small sawmills. Almost half of the large sawmills marketed unselectively to as many customer groups as possible. Furthermore, large and small sawmills marketed their products in as many countries as possible, while the medium-sized sawmills concentrated on few, well specified countries (Juslin and Tarkkanen 1987). The study also showed that product planning is raw material-oriented in the sawmill industry and that large sawmills are most raw material-oriented.

Niemelä (1993) analysed large sawmills marketing strategies using two different strategy concepts: Porter’s (1980) model of overall competitive strategy and the marketing strategy concept by Juslin and Tarkkanen (1987). According to Niemelä, Finnish sawmills have a more advanced marketing strategy emphasising speciality- and custom-made products and few customers and market areas comparing to Western North American sawmills. Furthermore, the Finnish sawmills are also applying more advanced competitive strategies. However, 78 % of the respondents indicated that their sawmill’s strategy had components from more than one of Porter’s three different strategy types. Niemelä suggested that the differences between the countries could be somewhat explained by the larger size of the Western North American sawmills and
especially by the domestic orientation compared to the export-oriented Finnish sawmills. Hansen et al. (2002) supported Niemelä’s results showing that nearly one-fifth of the studied sawmills made no clear choice regarding customer strategies. However, Hansen et al. (2002) suggested that large sawmills with multiple mills and extensive resources may be able to successfully pursue multiple strategies. The authors proposed that there may be a need for theoretical and methodological adjustments to better reflect viable strategic options and measure multiple strategies.

Bush and Sinclair (1991) described market and production strategies among groups of hardwood industries based on cluster analysis. Roos et al. also applied cluster analysis in order to explore production (2001) and value-adding (2002) strategies in the Swedish sawmill industry based on data from 1995 sawmill inventory (Warensjö and Jäppinen 1997a; Warensjö and Jäppinen 1997b). According to Roos et al. (2001) production strategies could be described along three main dimensions: value-add, size, and labour productivity. Depending on the specific characteristics and expectations emphasise could be put differently on the strategic dimensions. The study identifies six groups of sawmills concerning value-added shares, size, and labour productivity related to location, ownership, technology and economic profitability. The results in both studies by Roos et al. suggest that adding value increases profit margin levels (e.g. niche and high grade products); however, value adding could also imply high investments and thus, increase risks. In Roos et al. (2002) nine groups of Swedish sawmills are identified regarding combinations of applied value-adding production processes. The authors suggested that different value-adding strategies can be explained to a large extent by the search for competitive advantages on niche and upgrade markets.

Nord (2005) described and analysed eight large Swedish sawmills' strategies through case studies. The results showed the sawmills are becoming more market-oriented in their approach to strategy and thus, market sensing and customer linking activities were evident among the sawmills. It is suggested that the sawmills are forming their strategies based on market opportunities more than on resources. As a reason, Nord suggested that mapping of the Swedish sawmill industry could be based on portfolio of market opportunities and company size.

Gustafsson (2006) identified logistics service requirements of house-building companies, DIY multiple retailers, and traditional retailers on sawmills. Logistics strategies among the Swedish sawmill industry were explored. It was suggested that the sawmills could use nine generic logistic strategies such as postponement, differentiating, reducing or adapting to uncertainties, strengthening the internal and external integration, and improving information processing and decision support systems. The author suggested that the sawmills’ utilisation of generic logistic strategies is restricted by the supplier market, the characteristics of the raw material, the inherent nature of commodity products, and the divergent material flows.
5 Methodology

5.1 Methodological approach

The most fundamental methodological difference concerning ways to approach a problem is between experimental and non-experimental methods. According to Yin (1994), each approach has advantages and disadvantages depending upon three conditions: (1) the type of research question, (2) the control an investigator has over actual behavioural events and (3) the focus on contemporary as opposed to historical phenomena. This study’s broad research purpose and the associated research questions together with the unfeasibility to control the sawmills’ procurement processes called for non-experimental methods. My assumption was that qualitative interviews would generate deeper information about the procurement process than a survey through the possibility to ask open questions and follow-up interesting statements and thus, a qualitative approach was chosen. The study focuses on the current state, even though historical information could be a valuable input to better understand the present situation. My idea that this study’s broad research purpose of a complex process called for a qualitative approach was based on two reasons: the quantitative character of much of the earlier research within the wood procurement field and Yin (1994) and Ellram's (1996) arguments that case studies focus on contemporary phenomenon in real life settings.

5.2 Research process

The research process has been iterative; data collection alternating by deeper literature studies and data analysis followed the initial literature review (Figure 8). In the very beginning of the study, the focus of the study was primarily on information exchange between actors in the supply chain. The literature review and discussions with practitioners and research colleagues convinced me that the study object required a broader focus to include both strategic and operative issues.
The research object in this study was primarily sawmills’ procurement process, and thus, each case consisted of one sawmill and some related companies (contractors and suppliers) involved in the process. This implies that the organisational borders were not limiting the studies in order to get different perspectives on the procurement processes. This approach increased the complexity of the study. Accordingly, the study was regarded as having an embedded multiple-case design, which means that every case consisted of multiple units of analysis (Yin 1994). The embedded units are lesser units than each case itself, such as the sawmill's contractors or suppliers. The embedded units should be clearly embedded within the larger case, as the latter is the major interest of the study (Yin 1994).

In total, seven purchasing softwood sawmills in Denmark, Finland and the south of Sweden were studied between 2001 and 2003 (Table 2). Each case's conclusions contribute to the whole study even though each case remains a single case (Soy 1997). Thus, one reason for having several cases is that evidence from multiple cases is often considered more compelling and thus, the overall study is regarded as being more robust (Herriott and Firestone 1983). Another reason was to focus efforts on theoretically useful cases that replicate or extend theory by filling conceptual categories (Eisenhardt 1989). The cases were chosen based on two principles: (1) they were versatile, i.e. brought comprehensive light to the phenomena being studied and (2) some of them were also interesting through being conceived as leading the development of procurement management by practitioners with knowledge of the trade. To obtain variation and achieve different categories among the cases, the sawmills’
were selected based on firm size (volume of production), type of procurement organisation and customers as well as market orientation (c.f. Nord 2005, chapter 4). The first part of the selection of cases was done through communication with researchers and practitioners in each country. The final selection was made on the basis of participants’ own volition and interest.

The author performed the Danish and Swedish studies while the Finnish forestry student Kasperi Karhapää did the data collecting in Finland with method support from the author and her supervisor. Before the start of the Finnish study, Kasperi Karhapää spent a couple of weeks in Sweden to learn about the study and its design, the terminology and processes. The author and Kasperi Karhapää also tested the interview-guide (Appendix A) on a former procurement forester. The author, her supervisor and Kasperi Karhapää, visited the Danish case companies before the interviews were performed in Denmark.

Use of case studies generally involves multiple data sources in order to produce evidence to understand the cases and answer the research questions. In this study, the main source of evidence was personal interviews, but also secondary data such as documents were a part of the data collection activities as they provide a rich source of information as well as construct validity and reliability. Data from documents are stable since they are usually produced for other reasons than research, which means that it is not possible for the researcher to influence them (Guba and Lincoln 1981) even though the researcher and the interviewees affect the access to and the collection of documents. The disadvantages with documents are that the content is not specifically intended for the purpose of the study (Riley 1963). In this study, tallies, documents relating to suppliers and other documents that were sent between the participants were of interest as well as the sawmills’ web pages and information leaflets. The possibility of employing several methods during data collection is an advantage of case studies in comparison to other methods (Merriam 1994).

All case studies involved on-site visits. First, a meeting with the contact person at the sawmills was held to discuss how the study should be performed and also to ascertain more information about the company. Furthermore, the contact persons at the sawmills were able to suggest suitable interviewees to represent the sawmill as well as contractors and suppliers. Comprehensive, yet target-oriented qualitative interviews were conducted with 46 individuals involved in the supply process. To attain more detailed knowledge about how procurement of sawlogs to purchasing sawmills could be managed, interviewees from different levels and positions of the company were interviewed. The expectation was to obtain knowledge about how the sawmills manage their day-to-day situations with regard to procurement based on the informants' statements (see e.g. Miles and Huberman 1994).
<table>
<thead>
<tr>
<th>Sawmill</th>
<th>D1</th>
<th>D2</th>
<th>F1</th>
<th>F2</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Business concept</strong></td>
<td>Customer oriented with prompt deliveries</td>
<td>Meeting the demands from customer within the group</td>
<td>Focus on meeting the needs of customers through flexible service</td>
<td>Aims to achieve the status of a specialist supplier of wooden structures</td>
<td>Meeting customer requirements and being the obvious partner</td>
<td>To be a secure supplier of sawn and planed goods</td>
<td>Specialised production to offer customised products</td>
</tr>
<tr>
<td><strong>Production size</strong></td>
<td>Small</td>
<td>Small</td>
<td>Medium</td>
<td>Large</td>
<td>Large</td>
<td>Small</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Main products</strong></td>
<td>Sawn goods and some further processed goods. Customised and specified products</td>
<td>Roof-truss timbers, glulam production, standard production goods</td>
<td>Sawn goods and made to order products</td>
<td>Sawn goods, poles, glulam wood and further processed goods. About 30% customer oriented</td>
<td>65% sawn and planed goods and 35% sawn goods</td>
<td>54% sawn goods and 46% further processed products</td>
<td>Sawn and planed goods. 3A: boards and CLS, 3B: roof battens</td>
</tr>
<tr>
<td><strong>Main customers</strong></td>
<td>Construction business</td>
<td>Approx. 60% to companies in the group</td>
<td>End user markets</td>
<td>Doesn’t have a specific marketing segment</td>
<td>House manufactures (21%) &amp; building materials retailers</td>
<td>Building materials retailers &amp; wholesalers</td>
<td>Building material retailers and DIY-stores</td>
</tr>
<tr>
<td><strong>Export vs. Domestic</strong></td>
<td>Domestic market and Germany</td>
<td>Principally the domestic market</td>
<td>85% exported</td>
<td>Export-oriented</td>
<td>65% domestic</td>
<td>80% domestic</td>
<td>Export-oriented</td>
</tr>
<tr>
<td><strong>Procurement staff</strong></td>
<td>The CEO purchases logs, quality check outsourced</td>
<td>One procurement manager employed by a timber trading company</td>
<td>8 people work with timber purchasing</td>
<td>One forestry manager, 22 procurement foresters</td>
<td>Four procurement foresters of which one is procurement manager</td>
<td>Two procurement foresters of which one is procurement manager</td>
<td>Four procurement foresters</td>
</tr>
<tr>
<td><strong>Number of interviewees</strong></td>
<td>7</td>
<td>9</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

a Size is based on reported sawmill production 2000/2001: small < 100,000 cu m; medium = 100,000 to 200,000 cu m; large > 200,000 cu m
b Some of the interviewees were suppliers to or worked for both D1 and D2, the total number was 12 people.
If possible, the interviewer and interviewee met before the interview to get to know each other. Based on the research questions and the literature review, interview-guides were developed to support the interviewer during the interviews (Appendix A). One guide was developed for each type of interviewee, e.g., salesman, procurement forester, contractor, and forest owner. The questions treated for example, the supply situation, the management of procurement, internal and external information exchange and relationships with actors in the supply chain as well as contextual issues. The interview questions were open-ended and concerned different themes derived from the research questions and the literature review. The themes were:

- the procurement process (strategic, tactical, operative)
- information exchange between actors in the procurement process
- use of information technology
- relationships between actors
- contextual questions

Despite the interview-guide, the interviews remained open-ended. The interviews were allowed to pursue a natural course, but all questions from the interview-guide were explored. During the progress of the study, the questions and the procurement model were developed to grasp the keys in the procurement process, however the themes remained the same. The flexible data collection made it possible to take advantage of emergent issues and unique case features (Eisenhardt 1989). The interviews were carried out in the interviewees' offices or homes and lasted for at least thirty minutes to more than three hours partly depending on the interviewees' involvement in the procurement processes. The interviews were recorded using a tape recorder except in one case where notes were taken due to an interviewee’s request. The interviews focused on the purchasing sawmills' procurement processes and the management of the processes. Two of the interviews were conducted at group level.

5.3 Evaluation and analysis of cases

The data analysis was a continuous iterative process (Figure 9) where each component entered successively as the study continued. The interviews have been analysed by data reduction, i.e. categorising by codes and clustering based on an approach suggested by Miles and Huberman (1994) (Start list of codes and themes are presented in Appendix B). The codes could be described as tags used to identify themes in the text and they were revised during the process. The embedded units of analysis have been analysed within each case and thereafter the results have been interpreted at the single-case level, as suggested by Yin (1994). The last step was to draw conclusions for the multiple cases.

Data collection and analysis have overlapped to reveal useful adjustments to data collection (Eisenhardt 1989), even though most of the analysis was done after finishing data collection. The same sentence in an interview could sometimes be
given several different codes since the same information could shed light upon
different aspects. The within-case examinations made it possible to gain deeper
familiarity with the data and start the preliminary theory generation (Eisenhardt
1989). After finishing the data collection in Finland, Kasperi Karhapää and Klara
Helstad together compiled and pre-analysed the Finnish cases. The cases were
analysed deeper by codes in connection with the analysis of the Danish and
Swedish cases. Focused, additional questions have been necessary in a few cases
to gather additional data in order to check some facts. Secondary quantitative
data has been collected to support the qualitative data. The participants have
reviewed and approved their contributions to the study as presented in the
included papers.

![Interactive Model of Data Analysis](image)

*Figure 9. Components of data analysis: Interactive Model (Miles and Huberman 1994)*

### 5.4 Quality of conclusions

The study was constructed and presented with the aim to ensure construct
validity, external validity, and reliability. In Table 3, it is described how the
different quality measures have been handled. According to Yin (1994), internal
validity is only applicable for explanatory or causal case studies and thus, explora
tory studies are not concerned with making causal statements.
<table>
<thead>
<tr>
<th>Quality measure</th>
<th>Measures taken in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct validity</td>
<td>- Use of multiple sources of evidence, i.e. interviews and documents (company specific information)</td>
</tr>
<tr>
<td></td>
<td>- Participants review their contributions to the included papers</td>
</tr>
<tr>
<td>External validity</td>
<td>- Variations in place (three countries) and people (several interviewees at each sawmill) and still yield the same findings (replication logic)</td>
</tr>
<tr>
<td></td>
<td>- External validity is sharpened through a specified population (purchasing sawmills) (Eisenhardt 1989)</td>
</tr>
<tr>
<td></td>
<td>- Cross-case examinations to look beyond initial impressions and find evidence (Eisenhardt 1989)</td>
</tr>
<tr>
<td>Reliability</td>
<td>- Procedures is documented in a protocol to make the study transparent and replicable</td>
</tr>
<tr>
<td></td>
<td>- Despite the interview-guides and due to the research design, the questions are developed during the study to catch the procurement process. Nevertheless, the themes remain the same</td>
</tr>
</tbody>
</table>
6 Presentation of the included papers

The outline of the thesis is based on the purpose and the research questions. The connection between the research questions, articles and cases are shown in Figure 10. The included papers explore different parts of the procurement process.

Paper I aims at outlining a contingency perspective on business level strategy and competitiveness in the sawmill industry. Prominent contingency factors of the Nordic sawmill industry are identified and discussed from a strategic perspective. In paper I and II, the supply market and other specific characteristics of the industry are illustrated in order to construct a basis for further exploration of components in the procurement process (Figure 11). Paper I discusses the sawmill industry in general while paper II explores the case companies specifically. Paper II explores how purchasing sawmills manage supply uncertainties in procurement of sawlogs through process improvement and buffer activities.

Paper III explores how the procurement staffs manage and build relationships with suppliers in order to secure supply. The supply structure and applied contractual forms are decisive for management of bucking. In paper IV, the
procurement process is explored with special attention to management and control in order to match raw materials against market demands and orders.

![Diagram of Thesis structure with Papers I, II, III, IV](image)

Figure 11. Illustration of the relation between the included papers and the thesis

The papers are presented in the following sub-sections.

### 6.1 Raw Material Procurement in Sawmills' Business Level Strategy - A Contingency Perspective

The sawmill industry is facing serious challenges; intensified competition, increasing substitution of wood for new materials and powerful customers posing extensive new demands.

The paper discusses the structure of the industry, factors behind the fragmentation, competition and market strategies as well as the production and procurement processes and characteristics of suppliers.

Obstacles for a change towards a more competitive configuration of the sawmilling industry are context and contingency related. Corporate strategy building must be based on an analysis of such factors. A contingency analysis of the sector reveals an array of factors that underpin severe fragmentation. Thus, sawmills have limited possibilities to exert power within the sawn wood supply chain. To break free from the ties of sector fragmentation, business level strategy may be based on:

- **Cost advantages** based on scale, production technology and productivity, a competitive strategy traditional to the sawmill industry.
- **Market domination** through new/superior products and unique offers to customers. The development of new products, such as EWP, and closer co-
operation with customers such as power retailers are examples of the second type of strategy.

- **Optimisation of raw material flows** based on market information. Control and management of raw material flows is important for the sawmill industry, as well as for other industries with similar production.

A sawmill with superior control of the inbound sawlogs will always have the upper hand on competition because it may produce and sell its products with high efficiency. In spite of their importance, these areas have received only limited attention. Controlled procurement, flexible management of forest operations and communication of short-term needs to the suppliers are vital issues for the purchasing sawmills, yet to be explored.

### 6.2 Managing supply uncertainties in procurement of sawlogs for sawmills

The procurement of sawlogs to purchasing sawmills is characterised by a high degree of unpredictability. As a result, procurement managers experience the decision-making environment to be in a constant flux. Furthermore, the sawmills are dependent on multiple suppliers, generally non-industrial private forest owners, and cannot apply a single or dual sourcing strategy. Activities that manage uncertain supply may be classified into process improvement and buffer strategies. Even though improving processes can reduce supply uncertainties, business environments innately contain uncertainty to a certain extent. This paper describes various types of supply uncertainties related to purchasing sawmills’ supply with exogenous as well as endogenous causes. Special attention is paid to understanding how purchasing sawmills reduce the risks related to supply uncertainties through process improvement and buffer activities. The paper is based on analyses of 38 qualitative interviews with people involved in the procurement process from six Nordic softwood sawmills. Out of the identified supply uncertainties, two main types could be recognised. On the one hand those related to deficiencies regarding information exchange, management as well as relationships with suppliers and contractors. On the other hand, those due to weather conditions and quality issues. The described uncertainty sources are to a fairly large extent possible to influence. The results indicate that sawmills are planning to work or working with various process improvement and buffer activities to reduce uncertainties in supply. The process improvement activities could be categorised into four main fields: developing relationships with suppliers, improving information exchange both external and internal, creating new organisation structures and improvement of bucking instructions and price lists. Examples of buffer strategies were controlling supplier inventories and developing the inventory systems.
6.3 Supplier relationships - a strategic element of sawmills' timber procurement management

The purchasing sawmills’ procurement process is complex and characterised by uncertainty, mainly due to the dependence on supply from multiple suppliers and the heterogeneous nature of sawlogs. Thus, for a sawmill, procurement of sawlogs is a strategic business process; the properties of inbound sawlogs are decisive for the output of sawn products and the costs of sawlogs contribute substantially to the cost of the final product. Increasing customer orientation and new demands from powerful customers in the building and retail sectors imply new or accentuated demands on management of procurement. Managing raw material procurement and communicating needs to suppliers and logging machine operators are vital issues for sawmills in order to be competitive. In this paper, purchasing sawmills’ supplier relationships are explored. The results are based on 46 in-depth interviews with people involved in the procurement process at seven softwood sawmills in Denmark, Finland and Sweden. The supply uncertainty makes it difficult to predict and manage procurement and as a result, securing supply seems to be put before the sawmills' and customers’ needs. All sawmills are dependent on local supply, mainly from private forest owners and keenly build long-term relationships to secure supply. Some factors appear that are important in order to be an attractive buyer: offer proper prices and services, develop personal relationships and inspire confidence, preserve the reputation through doing a good work, and have a good financial position. This work implies that sawmills require a relatively high number of procurement foresters employed. In Sweden, the relationships with large suppliers are associated with a higher degree of uncertainty than in Denmark. The difference is probably due to supply market characteristics and businesslike priorities by suppliers. The study shows no evidence for that sawmills' market approach influence supply structure and applied contractual forms.

6.4 Information exchange and management of bucking to improve precision in sawmills' raw material procurement

Managing raw material procurement and communicating needs to suppliers and machine operators are vital issues for sawmills in order to be competitive. Bucking is the first step in the conversion process and thus, highly affects the later production processes. In this paper, information exchange and bucking management are explored in sawmills’ procurement processes. In order to offer short time deliveries, sawmills could apply two different strategies; either produce towards orders or produce towards ready stock, i.e. the production is based on forecasts of the customers' needs. However, the first strategy has
considerable limitations and cannot be applied by sawmills with log-length systems and dried products.

The results show apparent differences in the intensity of bucking management. Yet, the three Swedish sawmills have similar approaches: standard bucking is based on price lists that reflect the long-term needs, typically for one year, while special bucking should respond to short-term changes in demand or to deficiencies (Figure 12). The price lists should reflect the sawmills' annual needs and attract suppliers in order to secure supply. Special bucking is generally applied in standing timber sales that give full flexibility, while standard bucking is suitable for cutting commissions and delivery timber. Changes of bucking in cutting commissions entail higher prices since the agreements are based on the general price list and cannot be changed without request. However, changes in bucking could be avoided through purchase of sawn products to support the internal production and thus minimise disturbances in production and procurement. Thus, to have flexibility in bucking, except from tree-length systems like in Denmark and USA, there are two alternatives: (1) a standing stock of standing timber purchases or (2) close relationships with selected suppliers.

The paper also discusses the use of information technology to support management of bucking.
7 DISCUSSION

In this study, procurement management has been explored through case studies of seven Nordic purchasing sawmills. The limited number of cases and the fact that the case companies were not randomly chosen imply a certain degree amount of caution in generalising the results. However, Yin (1994) argues that case studies are generalisable to theoretical propositions and not to populations or universes. The cases do not represent a "sample", and thus, the goal is analytic generalisation, i.e. to expand and generalise theories and not statistical generalisation (Yin 1994). Thus, inferences drawn to purchasing sawmills in general are tentative and further studies are required to validate the findings. Nevertheless, it is likely that the findings are relevant depending on the sawmill’s characteristics and environment. The aim with this study was not to attempt to generalise the results to other industries.

The choice of method imply limitations. First of all, the selection of individuals to interview implies that some individuals are not selected. This could imply that some ideas of interest are not being depicted. In this study several people were interviewed at each sawmill including contractors or harvester operators and suppliers and thus, the information from each interviewee complemented the others. The transcription, coding and analysis of the open-ended interviews involve a certain degree of researcher bias, even though measures have been taken to minimise it by for instance listening to the Danish and Swedish interviews after the first transcription and correct it. However, since the interviews in Finland were carried out in Finnish, the transcribed interviews had to be translated to Swedish for further analysis. In addition, the Danish interviews had to be transcribed in Danish. This was a disadvantage as transcription of tapes can be done in many ways that produce rather different texts (Miles and Huberman 1994). However, the use of two investigators in the Finnish part of the study provided an advantage by the variety of perspectives and insights while examining the data and the patterns (Soy 1997).

7.1 The procurement process

Managing procurement in an integrated way will not guarantee success but it can provide an opportunity to compete more effectively and increase productivity. The basis for this study is that sawmills’ procurement process highly influences the sawmills’ possibilities to effectively satisfy customers’ needs.
Drawing on earlier research on wood procurement and the analysis of the cases, a general conceptual model of wood procurement for the shortwood method has been derived (Figure 13). The model is a construct and in reality, sawmills’ procurement processes may deviate from the model to various degrees. Other flows than physical and information are not included in the model. The model acts as a foundation for the discussion.

**Figure 13. General conceptual wood procurement model for the shortwood method**

In Keipi (1978), Harstela (1993) and Uusitalo's (2005) wood procurement models, the procurement process starts by purchase of wood or timber reconnaissance. In contrast, I suggest that the procurement process starts with the identification of needs at the sawmill. The needs are based on customers' demand, forecasts of demands and inventories. In order to satisfy demands, identification of needs is the main activity and constitutes the foundation for the production and procurement plan. However, the findings of this study and Gustafsson (2006) indicate that some customer types such as house-builders know their requirements in advance while other types of customers such as building material retailers have little knowledge about their volume and product needs. Thus, the sawmills' possibilities to achieve sufficient information about demand differ considerably and therefore, forecasts based on last year's sales are often utilised.

The procurement process consists mainly of two parallel sub-processes: the order cycle process and the purchasing process. The order cycle process shall satisfy customers' demands and embrace several activities such as develop harvesting plan (selection of stands, allocate stands to contractors, specify appropriate bucking matrix), execute logging, manage storage and transports to the mill, and perform wood measurement. The purchasing process aims to supply the sawmill with enough volume of sawlogs and the right mix of stands and raw material characteristics to fulfil orders. Purchasing of stands is mainly based on forecasts.
of demand due to the long lead times from cutting in the forest to delivery to customers. This makes it difficult to respond to fast orders or changes in demanded volumes, dimensions and qualities by purchasing adequate stands. However, stands purchased as standing timber for sale could be utilised to fulfil a certain order if there are enough time to go through the whole order cycle and production process. Search for suppliers, pricing and purchases of available stands are primary activities in the purchasing process, while management of logging operations including bucking is the key activity in the procurement part of the order cycle process. At the smaller case companies, there are one or a few people that purchase wood and manage all activities in the procurement process. Thus, the information exchange with production and sales staff is based on simple techniques, however the staffs are near to each other and could easily exchange information. The larger sawmills could instead develop information systems or other tools to facilitate information exchange and decision-making that the smaller companies may not have neither economical nor practical reasons to install.

The applied harvesting system and the selection of contractual forms influence how the wood procurement process is structured. Based on the general conceptual wood procurement model and the results from the Danish case companies, the following model could be developed for Danish purchasing sawmills that apply the tree-length method and purchase wood as delivery timber.

![Figure 14. Procurement process model for Danish purchasing sawmills](image_url)

The theoretical framework of the procurement process (Figure 4, sub-section 2.1.2) could be compared with the conceptual wood procurement model (Figure 13). The first five stages in the procurement process are applicable on sawmill's procurement process, i.e. identify or re-evaluate needs, define and evaluate user requirements and decide to "make or buy" (further discussed in sub-section 7.2), conduct market analysis, and identify all possible suppliers. However, the power/dependence balance between seller and buyer influences the last four stages in sawmill's procurement process, which usually is to the suppliers'
advantage. Pre-screening of possible sources could be done; however, the main objective is usually not to reduce the number of suppliers. Evaluate remaining supplier base and choosing suppliers are also activities that are generally not applicable on sawmills. Instead, these activities could be applied when selecting contractors to perform logging and transport operations. The last step, post-purchase evaluation and performance feedback, is conducted to some extent, e.g. measurement. However, the aim is not to improve the NIPF work, rather, the control activity is utilised to improve the bucking matrix or logging and transport operations. Finally, it is suggested that the influences and factors affecting the procurement process (presented in the theoretical framework) are applicable on the sawmill's procurement process.

The analysis of the cases suggests that there are four key strategic dimensions in the procurement process in order to satisfy demands and manage procurement (Figure 15). Depending on the sawmills' specific characteristics and expectations the strategic dimensions could be emphasised differently. First of all, the findings show that the case companies keenly build relationships with suppliers in order to secure supply. The success of such a strategy depends on several factors such as individual factors of the procurement forester, the price and services offered by the sawmill, earlier experiences of transactions etc. The use of contractual forms has a great impact on the possibilities to manage procurement since it affects bucking flexibility and arrival of logs to the sawmill. The purchase of adequate stands and design of price lists are mainly tactical tools to manage the inflow and properties of sawlogs, while bucking is the operative tool to affect sawlog properties. Strengthen external integration with preferred suppliers and contractors are beneficial in order to manage procurement more efficiently and secure supply. The sawmills in this study use these methods differently and with more or less success as reported in Paper II, III and IV.

Figure 15. Strategic dimensions of the procurement process
7.2 Procurement's implications on sawmills' strategies

The sawmills' needs of sawlogs derive from their customer demands. Different customer groups have different product and service requirements (see e.g. Gustafsson 2006), whereof some affect the raw material requirements. The strategies applied by the sawmills' to fulfil their customers' demands vary. In Paper I, it is suggested that sawmills’ business level strategy can be based on (1) cost advantages based on scale, production technology and productivity, (2) market domination through new or superior products and/or unique offers to customers, and (3) optimisation of raw material flows based on market information.

In paper II, it is suggested that sawmills would have difficulties to adopt a lean or efficient supply strategy since both agility and leanness demand high levels of product quality and minimisation of total lead-times (Christopher and Towill 2001). Unfortunately, this study indicates that the sawmills' supply is far too unpredictable and risky to entirely adopt a lean strategy. Hence, the sawmills’ challenge is to increase flexibility and at the same time reduce lead-times and costs.

The results of paper IV indicate that sawmills' customer and product strategies strongly affect management of bucking since demands differ depending on customer type. However, the findings in paper III shows no evidence that sawmills' market approach influence supply structure and applied contractual forms. Instead, the general local raw material characteristics seem to be decisive for the product and customer mix, which is supported by Alkbring (2003). Actually, relationships with suppliers and contractual forms restrict bucking management, and thus the possibilities to meet customers' demands. The need for flexibility in bucking is dependent on each sawmill's strategy. Five different strategies are identified among the case companies: (1) unfocused standard production (F2, S1), (2) short time deliveries of a wide range of products (D1, S2), (3) customised production (F1), (4) focus on standard products to a few customers (D2), and (5) focus on a few standard products (S3).

This study shows that sawmills can apply two different strategies in order to offer short time deliveries (within 1-5 days), however only applicable on nearby markets:

- produce towards orders; requires bucking performed at the sawmill and delivery of un-dried products
- produce towards ready stock of sawn or planed products, i.e. the production is based on forecasts of the customers' needs.

The latter strategy involves a possibility to produce a stock of sawn products and then postpone planing until customer demands are known (cf. Gustafsson 2006). However, postponement of planing could affect production planning and
switching costs negatively. Another option is to purchase sawn or planed products from other sawmills in order to fulfil orders that minimise the effects on the own production and procurement process. This is currently applied by some of the case companies. Nonetheless, this strategy requires close co-operation with suppliers or the sawmill will be limited to purchase products on the spot-market.
8 CONCLUSIONS

Procurement is a key to satisfy customer demands and to reach sawmill’s goals and objectives. Managing procurement of sawlogs to purchasing sawmills is a complex process affected by many uncertainties. The first research question concerns how sawmills work to reduce supply uncertainties. Various types of supply uncertainties with exogenous and endogenous causes are identified. Process improvement and buffer activities that reduce uncertainties are recognised such as developing relationships with suppliers and creating new organisational structures as well as improving and increasing the information flow among participants in the procurement process. However, it seems as sawmills have considerable potentials in developing relationships with suppliers and improve internal and external information exchange in order to fulfil customer requirements.

The second research question concerns how sawmills manage supplier relationships. Building long-term relationships with local selected suppliers or segments of NIPF and develop adaptable systems for information exchange between the actors in the supply chain are key issues for the case companies in order to fulfil customers' requirements. The results suggest that securing supply is put before the sawmills’ and customers’ needs in the purchasing process. In Sweden, the relationships with large suppliers are associated with a higher degree of uncertainty than in Denmark. The difference is probably due to supply market characteristics and businesslike priorities by suppliers. There are no evidence for that the sawmills' market approach influence supply structure and applied contractual forms.

The third and fourth research questions concern how sawmills communicate their need of sawlogs to suppliers and contractors and how sawmills manage and control procurement through management of bucking. The modes of communicating demand information and bucking matrixes between the actors are based on very simple techniques. This study indicates a considerable potential for improving information exchange in the procurement process. The results show apparent differences in the intensity of bucking management. Yet, the three Swedish sawmills have similar approaches: standard bucking is based on price lists that reflect the long-term needs, typically for one year, while special bucking should respond to short-term changes in demand or to deficiencies. The price lists should reflect the sawmills’ annual needs and attract suppliers in order to secure supply. Special bucking is generally applied in standing timber sales that give full flexibility, while standard bucking is suitable for cutting commissions and delivery timber. However, changes in bucking can
be avoided through purchase of sawn products to support the internal production and thus minimise disturbances in the production and procurement processes.

The results from this study suggest that there are a number of ways to improve management of procurement, which are currently not fully employed. Four key strategic dimensions of the procurement process are identified. Based on the findings and earlier research, a general conceptual model of wood procurement to purchasing sawmills is suggested.

8.1 Managerial implications

The key decision-makers of sawmills must proactively seek to understand how costs and values are created in procurement to support other business processes. The models and strategic dimensions of wood procurement presented in this thesis allow practitioners to improve their understanding of how to develop and create procurement strategies and manage the procurement process. The characteristics of purchasing sawmills and procurement of sawlogs emphasise the need of strategic considerations. The major obstacle in the procurement process is the power/dependence balance in the relationships with suppliers. Beyond doubt, it restricts the manageability of procurement and particularly bucking. In this study, three solutions are put forward: build long-term relationships with suppliers, simplify the way of doing business through decreasing the number of contractual forms, and finally, ask the question: "Make or buy?" Below, these issues are further elaborated.

Long-term relationships can be developed with large suppliers. However, this study indicates that efforts in order to increase integration should preferably be built with suppliers without own sawmills or with a different mix of products. Market studies of both product and supply markets could identify strategic options. Furthermore, sawmills should develop relationships that fit the overall strategic goals and apply segmentation of suppliers as a tool to differentiate their service offers depending on how attractive each supplier or supplier category is. Olsen and Ellram's (1997a) model could be a starting point for analysing the supplier portfolio. There are possibilities to increase marketing efforts in order to attract NIPF. For instance, sawmills could offer suppliers Internet services similar to commercial banks to make NIPF able to follow their transactions, update forest management plans etc. This type of service is currently under development and applied by some Finnish and Swedish forest companies.

There are possibilities to simplify the way of doing business in Finland and Sweden by decreasing the number of contractual forms. This is also suggested by Uusitalo (2005). New trading methods are discussed in Sweden, such as pricing stems on the basis of data gathered by harvesters' computers (Möller et al. 2005) that could facilitate bucking management considerably. Another option is to purchase sawn or planed products from other sawmills in order to fulfil orders and avoid disturbances in the own production and procurement process. This is
currently applied by some of the case companies. Nonetheless, this strategy requires close co-operation with suppliers or the sawmill will be limited to purchase products on the spot-market.

8.2 Suggestions for further research

This research has focused on purchasing sawmills' management of procurement. In this study, four strategic dimensions have been identified (Figure 15) and the importance of these means to improve procurement management need to be quantified in order to provide normative suggestions. Further research within the subject could usefully explore the link between procurement management and procurement strategy as well as the connection to other functions' strategies and the corporate strategy. Particularly, the difference between individual sawmill and sawmill groups would be of interest to study since the latter type is more and more common. An international survey study of purchasing sawmills' management of procurement could give valuable information on for instance buyer-supplier relationships (not only NIPF), bucking management and make or buy decisions. Furthermore, studies of network roles in the procurement process and individuals controlling the information flow during the process would be of interest.
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Appendix A

Initial interview-guide

Background (sawmill staff, contractors, forest owners)
Age, Education, Former employment

Background (sawmill staff, contractors)
How would you describe your tasks?
Years on this position

Background (contractors)
Description of the company incl. number of employees and machines

Background (forest owners)
Current employment
Size of forest holding
How do you usually sell sawlogs?
How began the contact with the sawmill?

How the supply chain is structured (sawmill staff, contractors, forest owners)
Which people do you exchange information with regarding raw material procurement?
How the supply chain is structured (sawmill staff, contractors)
How is it decided what type of raw material that is needed?

Communication with actors involved in procurement (sawmill staff, contractors, forest owners)
What kind of information do you exchange?
How often? Is the information exchange sufficient?
How do you communicate? Would it be possible to communicate differently and how?
How could you influence communication methods?
How do you apprehend the information about the raw material? How could the information be developed?
What do you think influence how often you communicate?

Context (sawmill staff, contractors)
How do you or do you co-operate with other forest companies or sawmills?

Context (procurement staff, forest owners)
What contractual forms do you apply? Distribution and policies?
How is the pricing working?

**Context (procurement staff)**
What type of suppliers? Distribution?
How do you find new suppliers?
How do you experience the competition on the raw material market?

**Context (forest owners)**
How do you get knowledge about the sawmills raw material needs?
How do the sawmill communicate prices?

**General procurement management (sawmill staff, contractors, forest owners)**
How could the information exchange be developed between the sawmill, suppliers and contractors?

**General procurement management (sawmill staff, contractors)**
How could you affect or put demand on incoming raw material?
How could you manage the supply in order to fast respond to customers’ demands?

**General procurement management (procurement staff)**
How would you describe your raw material and procurement strategy?
# Appendix B

## Start list of codes

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