Wood procurement using harvest measurment

— For improved management of forest operations

Virkesanskaffning med hjälp av skördarmätning. För förbättrad styrning av skogliga verksamheter

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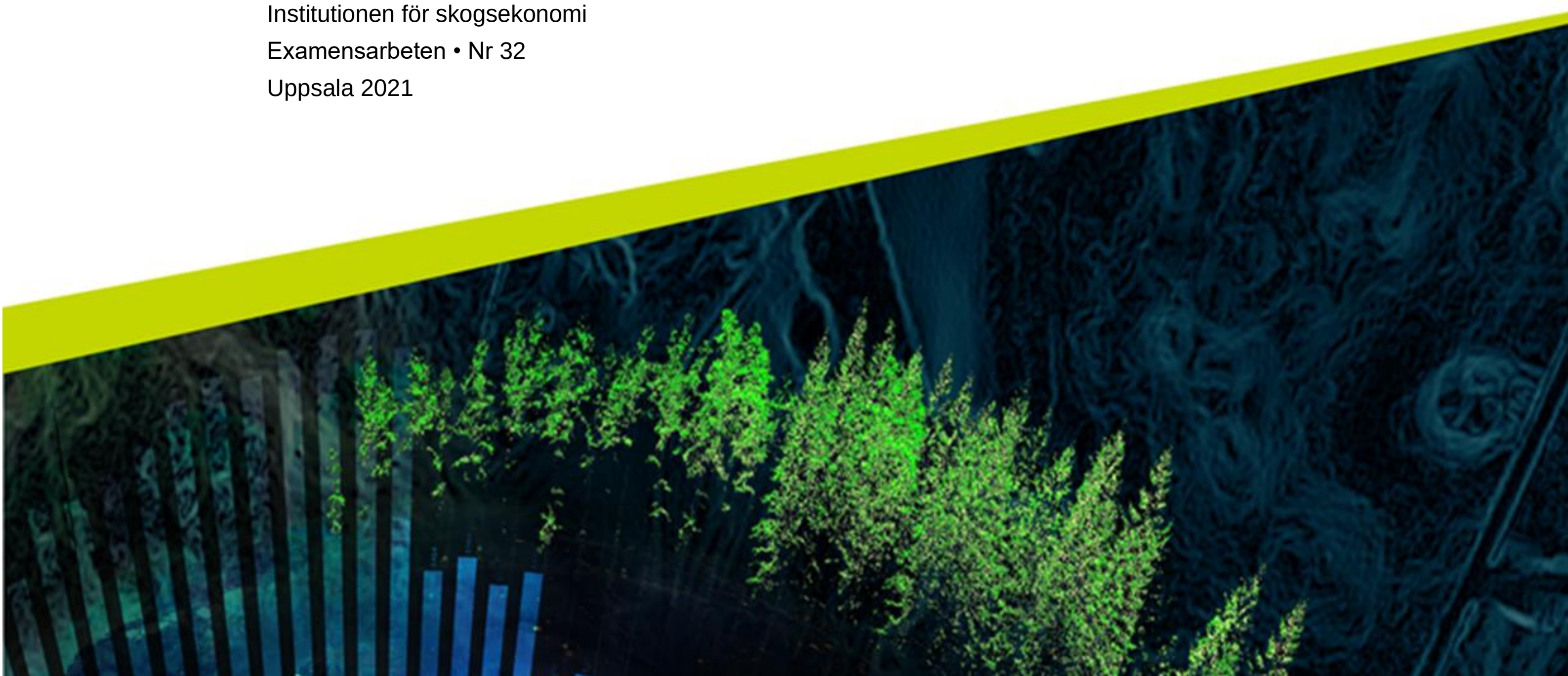

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Summary

Sweden is a world-leading actor in the global forest sector and remains in the top league of trading, research, and business operations. Despite being ahead of its competitors, several forest actors struggle with low profitability levels. The profitability index for private wood suppliers decreased by 0.45 units between 2000 – 2020, and sawmills' profitability levels are still low despite investments being record high in 2018 (financial performance due to COVID-19 are not considered). Wood procurement is a decisive process for several forest actor's profitabilities. For forest owners since selling wood is the primary income from their forest, and for sawmills because a large proportion of their costs are due to the procurement. Wood procurement is a complex process, including several participants and steps to complete. Process improvements could increase profitabilities for several actors and motivate further sustainability initiatives.

Studies have shown that the process along the wood supply chain can be improved with harvest measurement instead of industry measurement as payment basis. Potential in terms of reduction of lead times and improved supplier relationship are some of the findings. However, no studies have analysed whether waste can be removed and if costs can decrease by applying harvest measurement.

This study identified activities, information flows, lead times, and cost drivers within the wood procurement processes of both harvest and industry measurement. It demonstrated how waste, supplier relationship, and total costs are affected by the harvest measurement and identified non-value adding activities. Furthermore, the study explored opportunities for further improvements in the process.

A single case study was performed using qualitative methods. Interviews were conducted to perform a value stream map of the process, followed by an activity-based cost analysis to determine cost differences. Lastly, further process improvements were explored by combining the empirical findings with the latest research and development within wood procurement.

The result showed that harvest measurement as payment basis enable more flexible management of the logistics and bucking instructions. Overprocessing waste during contracting and making of the final invoicing is reduced. The supplier takes less risk and the cash flow is improved. On the other hand, the buyer takes a higher risk and gets a weakened cash flow. Measurement at the industry becomes non-value-adding. Lastly, lead time from harvest to supplier'recives his payment is reduced by half from eight to four weeks when harvest replaces industry measurement as payment basis. the main reasons for the differences are the change of ownership in the value chain, and the push flow becoming a pull flow in the end of the process when harvest measurement is applied as payment basis.

The activity-cost analysis indicates that the supplier's sales costs increase by 1.7 kr/m^3ub, and the acquisition cost for the buyer is reduced by 7.5 kr/m^3ub. Moreover, applying a digital contracting and planning process could reduce the acquisition cost further since a lot of the cost originates from time spent on these activities.

Keywords: *Lean, Supply chain management, supplier relationship management, total cost of ownership, value stream mapping*

Sammanfattning

Sverige är en världsledande aktör inom den globala skogsindustrin och återfinns bland världens främsta inom handel, affärsverksamheter och forskning. Trots en välutvecklande skogsindustri så är lönsamheten låg för flera aktörer. Skogsbruksindexet sjönk med 0.45 enheter mellan 2000 och 2020 för privata skogsägare, samtidigt som sågverks lönsamhet förblir låga trots rekordhöga investeringar under 2018 (finansiellt resultat till följd av COVID-19 ej medräknat). Virkesanskaffning är en avgörande process för flera skogsaktörers lönsamhet. Dels för att virkesförsäljning är skogsägares främsta intäkt från skogen, dels för att virkesanskaffning är en av de främsta utgifterna för sågverk. Virkesanskaffning är en komplex process och förbättringar inom processen skulle kunna leda till ökad lönsamhet för flera aktörer och motivera för ytterliga hållbarhetsarbete.

Studier har visat att virkesanskaffning kan förbättras genom att tillämpa skördarmätning som betalningsunderlag i stället för industrimätning. Inga studier undersökt skillnaderna i processen för att avgöra om slöseri kan minskas och hur de totala kostnaderna påverkas genom att tillämpa skördarmätning.

Denna studie identifierade aktiviteter, informationsflöden, ledtider och kostnadsdrivare inom virkesanskaffningsprocessen med skördar- respektive industrimätning. Studien demonstrerade hur slöseri, leverantörsrelationer och totala kostnader påverkas när skördarmätning tillämpas som betalningsunderlag, samt aktiviteer som blir icke värdeskapande. Därtill utforskade studien hur virkesanskaffningsprocessen kan förbättras ytterligare.

En fallstudie baserat på kvalitativa data genomfördes för att uppfylla syftet, med stöd av teorier kring verksamhetsstyrning. Intervjuer genomfördes för kartläggningen av värdeflödet inom processen, följt av en aktivitetsbaserad kostnadskalkyl för att identifiera kostnadsskillnader. Slutligen utforskades möjliga förbättringar av processen med hjälp av studiens empiriska fynd tillsammans med senaste forskningen och utvecklingen kring virkesanskaffning.

Resultaten visade att skördarmätning möjliggör en flexiblare styrning av virkeslogistiken, samt att apteringen kan bättre styras för att möta industrins efterfrågan. Skördarmätning leder till minskat överbearbetnings slöseri under kontrakteringen och slutredovisningen. Leverantören tar en mindre risk och får ett bättre kassaflöde medan köparen tar högre risk och får ett sämre kassaflöde när skördarmäning används som betalningsunderlag. Mätning vid industrin tillför heller inget värde för affärsledet mellan leverantör och inköpsorganisationen när skördarmätning används som betalningsunderlag. Skördarmätning leder även till halverad ledtid från avverkning till utbetalning, reducerad från åtta till fyra veckor.

Den aktivitetsbaserade kostnadskalkylen tyder på att leverantörens försäljningskostnader ökar med 1,7 kr/m^3fub och köparens anskaffningskostnader reduceras med 7,5 kr/m^3fub när skördarmätning tillämpas. Att applicera en digital plattform för kontrakteringsprocessen, och en digitaliserad traktplaneringsprocess skulle kunna reducera anskaffningskostnaderna ytterligare då en stor del av kostnaden härstammar från tiden spenderat på dessa aktiviteter.

Nyckelord: *Flödesekonomi, Lean, leverantörsrelationer, total ägandekostnad, värdeflödesanalys*

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With best regards,

Per Eriksson

Abbreviations

Abbreviation	Explanation	First introduced
ABC analysis	Activity-based cost analysis	Page 5
BPM	Business process mapping	Page 5
OM	Operations management	Page 1
SCM	Supply chain management	Page 5
SRM	Supplier relationship management	Page 13
TCO	Total cost of ownership	Page 12
VSM	Value stream mapping	Page 3

Table of content

1 Introduction

This chapter aims to provide the reader with a problem background for the study, followed by a problem that the study seeks to solve. Furthermore, the chapter will also provide an aim with research questions followed by the study's delimitations and outline.

1.1 Problem background

Sweden is a world-leading actor in the global forest sector and remains in the top league of trading, research, and business operations (Skogsindustrierna, 2020). Improvements within the sector have led it to become one of Sweden's most important economies, with a total export value of 145 billion SEK for 2020 (Skogsindustrierna, 2021). However, some actors within the forestry sector have experienced a decrease in profitability during the last decade despite the sector's significant export value. The profitability index for private wood suppliers decreased by 0.45 units between 2000 – 2020 (Skogsaktuellt, 2021) and sawmills profitability are low, despite investments being record high in 2018 (Lindström 2020). Furthermore, critique against the sector's environmental considerations has increased in recent years, both on domestic and European level (Bucht *et al*, 2021). Wood procurement is crucial for sawmills' profitability since it contributes to around two-thirds of the final product cost (Helstad 2006). Selling wood is also vital for the profitability of forest owners (Skogsaktuellt, 2021). Lastly, the procurement process makes a significant impact on ecosystems and greenhouse gas emissions. This indicates that improved operation management within the wood procurement process could lead to improved efficiency and profitability levels for several actors within forestry (Helstad, 2006) and enable improved sustainability initiatives (Piercy and Rich, 2015).

Companies worldwide are facing challenges regarding globalization and the public's increased awareness of environmental and climate issues. Forestry industries are no exception, and they respond partly by implementing new ways of managing their supply chains (United Nations Department of Economic and Social Affairs, 2021). Any supply chain requires frequent monitoring and improvement for an organization to remain competitive (Womack & Jones, 1996). Mapping different business processes and value chains within the forest industry is meant to identify and amplify value creation. However, Kotzab *et al.* (2010:826) argue that there is a lack of literature that covers the issue of "*how value is generated within forest-based supply chains from a holistic point of view.*" While as Singer and Donso (2007) point out, most literature focuses on the transformation or optimization of raw material and the utilization of sawmills resources. Furthermore, forest-related business seems to focus on cutting costs rather than covering all aspects of a company concerning flows, activities, coordination and customer needs (Guimier & Favreau, 2009).

Increasing the focus on value-creating instead of increased productivity and quantity may have a more considerable impact on a business's profitability (Roos *et al.* 2001). Innes (2009) declares that it is a natural consequence of industries operating for a long time to be conservative and reluctant to adopt changes, which many forest industries within Europe are. Furthermore, Innes (2009) also states that many forest companies in Europe struggle to make their business profitable. Thus, the issue of low profitability and reluctance to adopt changes such as innovative business models seem to be simultaneously present within forestry.

Identifying and removing non-value adding activities in a process is the desired way for companies to improve their operations and increase their profits (Chopra, 2019). It may be challenging to determine wheatear a current process has a non-value adding activity or not. Analyzing an existing process with a modified version of it is a way to determine if activates could be made non-value adding and removed. Since wood procurement is a decisive process for several forest actors' profitability, it becomes appealing to study the process and compare it with a modified version to determine if activities could be removed or improved.

1.2 Problem

Wood procurement is a complex business process where wood-demanding industries purchase resources from suppliers, such as private forest owners. The process generally includes purchasing, logging, transportation, and planning (Helstad, 2006). Additionally, wood procurement is seen as a basic strategic business process due to the raw materials decisiveness for the final products (Gustafsson, 2006). Furthermore, the raw material contributes to two-thirds of the cost for a sawmill’s final product, making procurement management vital for sawmills to remain competitive (Lindström, 2020; Helstad, 2006). However, the wood procurement process has not seen much change or adoption of new practical, operational, or managerial techniques despite its importance (Keipi, 1978, Harstela, 1997; Sikanen 1999; Helstad 2006). Continuously, Helstad (2006) argues that a possible way of simplifying the procurement business could be to apply the harvest-measurement technique instead of industry measurement.

Measurement of the wood volume to determine the supplier’s payment is a significant operation in the procurement process. Several measurement techniques exist to determine the raw materials value, whereas industry measurement such as log-to-log and pile measurement is the most common. Biometria is the national timber-measurement organization of Sweden and plays a central role in the nation's forestry industry. Biometria measured 80 million cubic meters of wood in the year of 2019. Nearly 90 percent of the volume was measured with industry measurement, while only 0.9 million cubic meters were measured using harvest measurement. The statistical data of the report shows that 93 percent of stack-measured pulpwood and 95 percent of stock-measured timber were within the law requirements for measurement accuracy. In comparison, 98 - 99 percent of the harvest-measured volume was within the law requirements (Biometria, 2020).

Studies have been conducted on harvest measurement and its potential to increase customer value, improve logistic-flows, reform lead times, increase measurement accuracy and redefine the risk a supplier takes when selling wood (Nilsson 2014; Eriksson, 2018; Nilsson, 2016; Tunstig & Magnusson, 2014; Karlsson, 2011). While no studies have identified the differences in the wood procurement process of industry and harvest measurement in terms of activities, information flows, and lead times. Thus, none of these studies have determined if any activity becomes non-value-adding, if waste can be eliminated and if differences in the process affect the supplier relationship. Neither have any studies been able to bring evidence for differences in total costs when using harvest measurement. In that sense, it becomes appealing to map the procurement process of both industry and harvest measurements to identify potential process and cost-benefits when using harvest measurement. Furthermore, mapping both processes could support innovation of the procurement business to increase profitability for all participants within the value chain.

1.3 Aim and research questions

This study aims to identify activities, information flows, lead times, and cost drivers within wood procurement processes of both harvest and industry measurement. The intent is to demonstrate how waste, supplier relationship, and total costs are affected when using harvest measurement and if any activity becomes non-value adding. Furthermore, the study intends to explore opportunities for further improvements of the process when using harvest measurement combined with the latest developments within wood procurement. Three research questions were formulated to assist in the fulfillment of the aim:

- Are there differences in activities, lead times, information flows, and cost drivers in wood procurement with harvest measurement compared to industry measurement?
- How do the differences impact waste, supplier relationship, and total costs within the process, and does any activity become non-value-adding?
- Is it possible to improve the process further when looking at the latest developments within wood procurement?

1.4 Delimitations

This study focuses on mapping the wood procurement process of industry and harvest measurement. Furthermore, the study focuses on the forest company of Södra Skogsägarna. The study has been limited to the district office of Långasjö and a few officials from the industry. It has also been limited to the activities that occur from the contracting process until the wood arrives at the industry. Therefore, this study is limited to the first business flow between the supplier and the procuring organization, there is also a second business flow between the procuring organization and the industry which is not covered in this study. The study does not intend to provide statistically verified costs for each activity, but rather what cost drives and cost pools there is. It focuses on identifying differences regarding lead times, information flows and interaction between activities within the value chains and what cost-benefits there are when using harvest measurement instead of industry measurement. Furthermore, the study intends to discuss suggestions, based on the study's findings and research on technological developments, on how to improve the procurement process further. The study’s findings will hopefully encourage further analyzes on the value chain with empahisis on quantifying the differences and the potentially improved operation management.

1.5 Outline

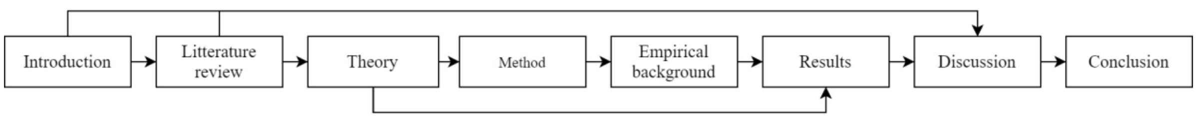

Figure 1. The outline of the study divided in nine chapters.

The first chapter of this study briefly introduces the topic (Figure 1). The second chapter presents a literature review. The third chapter provides a theoretical framework. The fourth chapter presents the chosen methods for the study. The fifth chapter provides an empirical background. The sixth chapter will present the result with the empirical findings and the analysis of those. The seventh chapter will provide a discussion and lastly, the eighth chapter will provide the conclusion of the study.

2 Litterature review

This chapter provides a literature review of studies and scientific articles related to the field that this study aims to investigate. A synthesis of knowledge gaps related to the wood procurement process within forest industries will be presented at the end of this chapter.

The literature focused on previous studies on business process mapping, supply chain management, and especially wood procurement within the forest industry. Literature has been gathered from the databases SLU primo, uppsatser.se, ResearchGate, and Google Scholar. Specific key words that have been used are “harvest-measurement”, “wood procurement”, “value stream mapping”, “business process mapping”, “business process innovation”, “supply chain management”, “activity-based cost analysis”, “total cost of ownership”, “supplier relationship management” and “forest industry”. A summarization of the most relevant literature gathered is presented in table 1 followed by a detailed review of the most relevant literature, including other relevant articles and studies.

Table 1: Reviewed studies related to the study’s field of interest, ranked by their relevance

Authors	**Aim**	**Conclusions**
Kotzab *et.al* (2010)	*Determine the applicability of SCM, VSM, and ABC analysis in the forest industry to eliminate inefficiencies and waste*	Combining SCM, VSM and ABC analysis as a framework makes a strong tool for optimizing forest-related value chains.
Hellstad (2006)	*Explore how sawmills manage the procurement process and how to improve the management*	Four different procurement strategies was presented. *Build supplier relationships, procure wood that suits the needs, and develop the contractual form based on pricing and bucking.*
Nilsson (2014)	*Study what is motivating for a private forest owner to use harvest-measurement in a procurement contract and determine the difference in lead time compared to pile-measurement*	The lead time from harvest to payment was more than half as short with harvest measurement and all expectations from the private forest owner on Södra. Only 7% declared that they wouldn’t use log-pricing again.
Tunstig & Magnusson (2014)	*Determine if transport lead times during the procurement process leads to loss of capital*	The supplier is affected by a small loss of capital due to prolonged lead times during transport. Harvest measurement might reduce the risk for loss of capital
Eriksson (2018)	*Provide guidance in how different factors affect the measuring accuracy*	All factors studied by the author did have an effect on the measurement accuracy. Having a well-calibrated harvester-head is important to ensure reliable measuring.
Nilsson (2016)	*Conclude if measuring accuracy differ between a small and a conventional harvester*	The study showed that a small harvester does have a slightly lower measuring accuracy. It is also mentioned that harvest measuring as a payment basis is reliable.

Operations management (OM) and business process modeling (BPM) are extensively studied and practiced. Research on the applicability and usage of OM and BPM within forestry-related supply chains has been conducted in several ways, whereas several studies have pointed out the importance and advantage of a broad understanding of the concepts (Kotzab *et al.* 2010; Innes, 2009; Björheden, R & Helstad 2005; Helstad 2006).

Kotzab *et al.* (2010) did research where they determined the applicability of supply chain management (SCM) a sub-are of OM, value stream mapping (VSM), and activity-based costing (ABC) in forest industries. VSM is a well-known lean tool to identify information flows, lead times, value, and non-value adding activities within a supply chain (Chopra, 2019), whereas an ABC-analyse is meant to assign the cost of each activity to a specific product (Bhimani *et.al* 2015). Seth and Gupta (2005), who conducted a case study of the supplier's end for an auto industry in India, argues that a VSM can be applied for any type of business, either if it is upstream or downstream. Furthermore, Seth and Gupta (2007) argue that the method is a very powerful tool when seeking inefficiencies, communicational and transactional mismatches, and a tool to deliver suggestions for improvements. Continuously, the authors agree with Rother and Shook (1999) that "*whenever there is a product for a customer, there is a value stream.*" Kotzab *et al.* (2010) made use of both quantitative and qualitative data from both primary and secondary sources. The study's main findings were that each of the approach they investigated had different ways of revealing optimization potential within a supply chain. Therefore, combining VSM, ABC-analyse and SCM to a framework seems to provide a strong optimization approach for forest industries to make better decisions concerning flows, activities, and customer focus. The authors' framework is presented in figure 2.

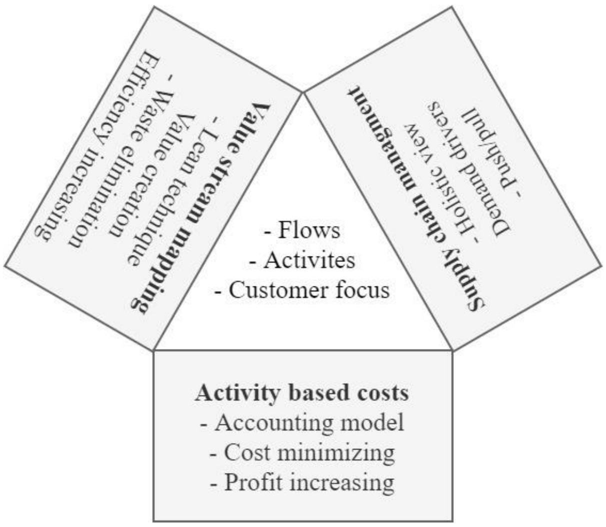

Figure 2: Combined framework of Value-Stream-Map, Supply-Chain-Management, and Activity-Based-Cost analysis to optimize forest industry processes (Kotzab et.al, 2010:838).

Björheden & Helstad (2005) wrote an article regarding wood procurement in sawmills on a business level strategy where they discussed wood procurement process and supplier relationship amongst other topics. The authors argue that the sawmilling industry face several challenges for achieving more competitive market positions. The suggestions from the authors are that a sawmills business level strategy should be based on: *Cost advantages* regarding technology and productivity, *market domination* by offering new solutions and improved co-operation with customers, and *optimisation of raw material procurement* whereas the flow of material and supplier relationship should be in focus. Limited attention has been given to the *optimization of raw material procurement,* and only a limited amount of research has been conducted, despite the importance, according to the authors. Lastly, it is stated that control of the procurement process and supplier relationship is vital for sawmills to remain competitive. Helstad (2004) also pointed out in her article of “Managing supply uncertainties in procurement of sawroundwood for sawmills” that the procurement process could be improved by the application and improvement of four different fields; supplier relationship, improving information flows both internally and externally, developing new organization structures and improve bucking instructions and price lists.

Rasmus Nilsson (2014) did a project with the title of *“Customer satisfaction among private forest owners who have used Södras’s timber procurement contract form “harvester measurement with a stem price.”* Nilsson (2014) studied if the procurement contract form of harvester measurement with a stem price would lead to higher customer satisfaction among the association’s members and whether the lead time in the trade- and transport process was different. Customers of the association are equal to the suppliers of the association's industries. Nilsson concludes that the main factor that motivated a supplier to choose the stem-pris procurement contract was because the buyer took all the risks associated with the felling assignment. He also concluded that supplier receives the payment once all timber has been harvested and is not affected by wood-shrinking or if the harvester cuts to length with a margin of error. Furthermore, the study showed that the supplier’s source of information regarding harvest measurement and stem-price was the forest inspector. And the last conclusion of the study was that the lead time from standing timber to the supplier was about half of the corresponding time for the pile measurement, but the lead time from standing timber and final measurement at the industry was about 13% longer.

In the article “The promotion of Innovation in forestry: a role for government or others?” John L.Innes (2009) attempted to understand why there is a reluctance to enact innovative changes within the forestry sector. The author argues that there is great potential for the forest sector to increase its profitability but also contribute with solutions for a circular bioeconomy. Innes concluded that there has to be a collaboration between all interested parties, such as governments, industries, academia and NGO:s to push the sector to enact innovative and sustainable changes. Benjaminsson *et al.* (2019) looked at what parameters in business innovation are most important for forestry service contractors regarding the low level of profitability. They concluded that knowledge about the performance related to the design of the business model would add valuable knowledge for “business development and innovation within a sector that struggles with low profitability.”

Helstad (2006) wrote the thesis “managing timber procurement in Nordic purchasing sawmills,” where the author aimed to explore how sawmills managed the procurement process. According to the author, sawroundwood' decisiveness for sawmills' final products makes the procurement process vital for the industries to achieve customer satisfaction and simultaneously remain competitive. Furthermore, the author states that managing information and the logistics flows within the procurement process is also crucial to remain competitive. Major obstacles within the procurement process identified by the author were the dependency on the supplier relationship, which limited the manageability of bucking. Continuously, a managerial implication found by the author is that any wood procuring industry “must seek to understand how costs and values are created in procurement to support other business processes”. The author provided four strategic dimensions for participants to improve their understanding of the procurement process and improve it. The author's four strategic dimensions are presented in figure 3.

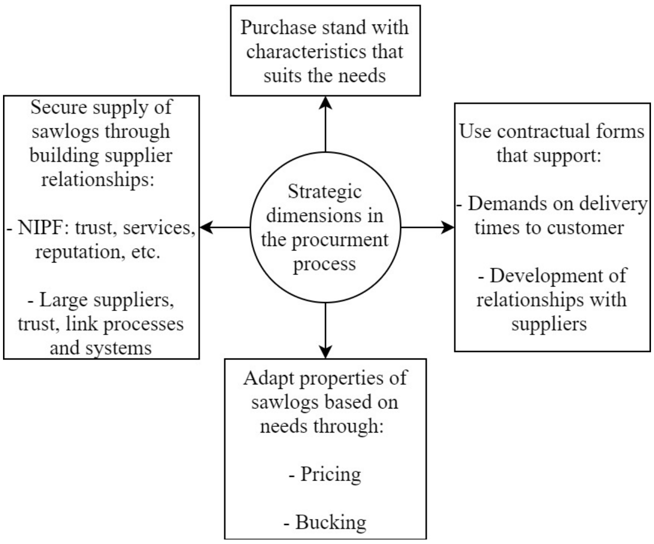

Figure 3: The four strategic dimensions for the wood procurement process (Helstad, 2006:43).

Helstad (2006) suggests that further research should be conducted on quantification of the process“ to provide normative suggestions” as well as network roles and information flows during the process. Lastly, the author also suggests that research should be conducted on harvest measurement potential to improve the procurement process and possibly lead to reduced costs, new ways of managing supplier relationships and new ways of managing information flows within the process. Tunstig and Magnusson (2014) assume, for instance, that the supplier’s costs considering loss of capital interest, shrinking, obsolescence and forgotten wood in a procurement process would be eliminated with the use of harvest measurement. Furthermore, Eriksson (2018) and Nilsson (2016) studied the accuracy of harvest measurement to conclude whether it is a reliable technique or not. Both studies concluded that harvest measurement provides a high measurement accuracy and would not negatively affect the suppliers' profit if it were the standard method in the procurement process. Biometria's report of measurement accuracy aligns with the findings of Eriksson (2018) and Nilsson (2016), Biometria state that 99% of the harvest-measured volume in Sweden was within the law requirements (Biometria, 2020). Lastly, a report from Skogforsk written by Willhelmson et al. (2019) points out that harvest measurement could lead to higher measurement accuracy than measurement techniques where individual roundwood are assessed.

The literature review provides evidence that OM and BPM is applicable within most industries, including forestry. Knowledge of how and where value is created within a process is crucial for any organization’s competitiveness, especially for industries who struggle with low profitability like forestry. Improving processes concerning information flows and obliteration of non-value adding activities is necessary for a firm to strengthen its competitiveness. Though, the forest industry seems to focus on rationalizing rather than changing current business processes. Furthermore, the procurement process within forestry is complex and vital for the industry's competitiveness considering the material decisiveness for final products and that raw material is one of the industry's main expenses. It seems that supplier relationship management is crucial for a profitable procurement process as well as the management of logistics and information flows, but there seem to be a knowledge gap concerning the quantification of the procurement process as well as how the information flows appear in the process. Furthermore, suggestions on research concerning harvest measurement costs and process benefits for the procurement process have been proposed, but there seems to be limited research on whether these benefits exist and what impact they would have on the process.

3 Theory

This chapter will provide the theories used in this study to get a fundamental understanding of the problem and find an approach to solving it. A general description of each theory, and their connection to the problem will be provided. Finally, a conceptual framework will be provided to illustrate how the problem is approached theoretically.

Concepts, theories, and tools from lean management, total cost of ownership, business process modeling and supplier relationship management were chosen to address the study's objective, argued by the fact that wood procurement is complex and requires a wide range of theories to asses its structure and costs. This chapter begins with lean management, due to leans objective to investigate and improve a value stream to achieve perfection (Womack and Jones, 1996). The next part covers business process modeling focusing on value stream mapping (VSM) and its purpose for an organization to identify and value activities in a value stream. Continuously, theories of total cost of ownership will be presented to understand different costs related to acquisition, ownership, and post-ownership. Lastly, a short review of supplier relationship management and why it is necessary for a firm's competitiveness will be presented, followed by a tool, activity-based cost (ABC) analysis. ABC-analysis aims at categorising activities according to importance and to identify cost drives and cost pools within them. This chapter ends with presenting the study's conceptual framework and how the theories, concepts, and tools have been applied.

3.1 Lean management

Lean is a concept meant to improve productions until they reach perfection (Liker, 2004). Womack and Jones (1996) define the term by five key principles; value, the value stream, flow, pull, and perfection. Table 2 defines the five different lean principles.

Table 2: Lean principles and their definitions (King, 2009:35)

Lean principle	**Definition**
Value	Value is equal to what the customer is willing to sacrifice for a product or service, which entails that value also can be defined by the customer's needs. Therefore, determining the customer value is critical to implement the four other principles successfully.
Value Stream	The value stream represents all value-adding and non-value-adding activities that are essential for a product or service to run from drawing, development, processing of raw material, and delivery and payment from a customer.
Flow	Flow ensures that products and services flow continuously from drawing to delivery. Hence flow removes any non-value-adding activity. Flow is achieved by defining the customer value and fulfill it with the least amount of delay.
Pull	A pull system is where the "upstream supplier produces something only when the downstream customer signals a need". As a result, inventory levels are reduced to a minimum and delivered at the right time with the right amount.
Perfection	Removing waste in the value stream and achieve a continuous flow will, in theory, lead to perfection. Applying all four previous principles will enable any value stream to *"to move toward perfection through continuous improvement (kaizen)"*

Being aware of customer values is necessary to fulfill the five principles and eventually reduce waste (Liker, 2004; Womack and Jones, 1996). Firms determine the value created within a supply chain by subtracting the output value with the input, which gives the *supply chain surplus* (Chopra, 2019). Increasing the surplus is desired by any firm to increase profitability, whereas coordinating all activities from raw material to customer within a supply chain becomes crucial. Coordination of the activities are referred to as *supply chain management.*

Three different activities occur in a process, non-value-adding, necessary but non-value-adding, and value-adding activities (Monden, 1994). Non-value adding is an activity that does not add any value for anyone in the process. Necessary but non-value-adding are action or activity that does not add any value, but it must occur in the process to make the operation possible. Value-adding are activities where the output of the operations contains a higher value than the input. An organization should aim at minimizing non-value-adding activities and focus on improving value-adding activities.

Even though lean production was originally thought to improve production lines, implementing lean thinking in organizations has proven to be useful in all kinds of sectors (Krajwski *et al.* 2013). Additionally, the concept of lean is constantly under development and may serve different purposes for different organizations (Pettersen, 2009). Womack and Jones (1996) argue that perfection is achieved by constantly improving the organization and remove waste. Common types of waste are those described within the lean concept of Muda (Hines & Rich, 1997; Heizer *et.al*, 2017). The wastes are the following;

Overproduction
When the production volume is of a size or pace that causes damages on quality, flow and production, waste in terms of overproduction occur. Reducing overproduction and focus on value-adding activities instead will help to reduce this type of waste.

Waiting
Whenever there is a task queueing for the next process stage, or a task that is idle within a process, waste in the form of waiting will occur. Therefore, reducing waiting may require a capacity increase or refining of the pull policy.

Transportation
Transportation waste refers to the unnecessary movement between stages of a process, which occurs in manufacturing and within knowledge work. Reducing transportation waste is done by monitoring the process and implement improvements wherever that is possible.

Processing
Processing can, in some cases, be more complicated than necessary. Whenever there is a gap of knowledge between the customer’s demand and the product designer, waste of over-processing can occur. Reducing this waste is done by ensuring that the process is as simple as possible and ensuring no overcomplicated steps.

Excess Stock
Inventory is always present in production and appears in the accumulation of finished products and work in progress. This type of waste is reduced by implementing just-in-time principles and ensure that any task is pulled through the process.

Unnecessary motion
Waste in terms of transportation regards movement between processes, whereas unnecessary motion refers to a movement within a process. For example, improving a manufacturing process reduces unnecessary motion within a manufacturing process and developing a document management system may be a way to reduce waste within knowledge work.

Mistakes and defects
The cost of a defect will increase proportionally with the time it takes to notice it. If a defect reaches the end consumer, customer satisfaction will be poor, and there will be a cost of redoing the work correctly. Reducing mistakes and defects may be done by constant testing and quality assessment of each process to ensure that a minimum amount of mistakes is made and that no defects reach the end consumer.

3.2 Business process modeling

A business process is a sequence of repeating activities that generate value for a customer and profit for the executer. Analyzing and modeling a process is typically made by identifying start to end activities and what is happening within each activity. Value-stream mapping (VSM) is a lean-management method to identify a process's current state and design an improved future state (Manos, 2006). VSM aims to identify activities and their contribution to the process, whether they add value or not. Additionally, a VSM is also meant to determine lead times, information flows, and flow of material. Having mapped a process is meant to bring knowledge for better operations management in the future. How the VSM method is used in this study is described in chapter four.

3.2.1 Lead times

A central part of value stream mapping is the determination of time between and within activities. Lead times refer to the time from an order of a good or execution of activity until it reaches the end consumer (Chopra, 2019). Lead times are often seen as crucial when considering customer satisfaction. Therefore, a firm may increase its competitiveness by shortening lead times and improve customer satisfaction. Measurement lead times are crucial within forestry industries due to the complex transportation system, capital-intensive purchases, and biodegradable material (Helstad, 2006). This study intends to identify the lead times that occur within the procurement process of wood, with the intention to determine whether harvest measurement can decrease the lead times and increase the service provided to the customers.

3.2.2 Information flows

Information flows are the streams of information from one state or part of the process to another. These flows may be manual, semi-automated, or fully automated and may be transferred analogically or digital depending on the purpose and properties of the information. Since wood procurement includes handling of a vast volume of goods, efficient and reliable information flows become crucial (Helstad, 2006). This study intended to determine wheatear information flows are improved by the application of harvest measurement or not.

3.3 Total cost of ownership

Whenever a procurement process takes place, it is important not only to consider the quoted price but also to look at other factors affecting the total cost. For instance, an expensive supplier who provides the material with short lead times could have a lower total cost than a cheap supplier with long lead times and vice versa. Additionally, a reliable supplier could be worth much more in terms of safety and continuous flow. Therefore, a supplier's cost is only one of many factors affecting a supply chain's surplus, which signifies the importance of focusing on the total cost of ownership (TCO). TCO is often described by categorizing all the associated cost in a procurement process from supplier to arrival at the buyer's site. The three different categories are acquisition cost, ownership cost, and post-ownership cost. Acquisition cost refers to all costs occurring in the procurement process from supplier until it arrives at the buyer and is ready for use. Costs included in acquisition costs could be the price of the supplier, transportation and logistics costs, and suppliers' terms. Ownership costs refer to the cost occurring after the procurement has arrived at the buyer and until it has been processed into the final product, such as storage, quality degradation, and production costs. Lastly, post-ownership costs refer to any cost that occurs after the final product has reached the end customer. These costs could be anything that still affects a firm after the finished product has been delivered, such as warranty and refunds (Chopra, 2019). Table 3 presents factors that may be included in either acquisition, ownership or post-ownership costs and whether these may be quantifiable or not.

Table 3: List of general factors within the three categories of total cost of ownership (Chopra, 2019:437-439)

Performance category	**Category Components**	**Quantifiable**
Acquisition Costs		
Price of supplier	The market price of the material	Yes
Terms of Supplier	Time of delivery, payment terms, and discounts	Yes
Taxes	Value-added tax, tariffs	Yes
Transportation and logistics	All costs related to the transport of the material from the supplier to the buyer	Yes
Cost of incoming quality	Quality degradation of any sort and cost of inspection	Yes
Cost of management	All cost related to the management and planning of the procurement	Difficult
Ownership Costs		
Costs of inventory	Cost within all stages where there is an inventory process.	Yes
Cost of warehousing	Handling of the material and additional cost related to the warehouse	Yes
Cost of manufacturing	Manufacture process of the procured material	Yes
Costs of production quality	The quality impact on the finished product due to the quality of the procured material	Difficult
Costs of cycle time	The time impact on the production cycle from the procured material	Yes
Post-ownership costs		
Reputation	Costs related to bad reputation followed by quality problems caused by the procured material	No
Costs of warranty and product liability	Any warranty or liability cost associated with the delivered final product	Difficult
Environmental costs	Any environmental cost that has arisen from the delivery of the final product	Difficult
Capabilities of supplier	Duration until replenishment, the supplier's flexibility and forthcoming	To some extent

All three cost categories must be considered when calculating the cost of material procurement for a firm. If any factor is excluded, the total cost of ownership will not be identified. Furthermore, identifying cost within all three categories may show that lower ownership and post-ownership costs may compensate a high acquisition cost. All factors may not easily be placed at once for a more prominent firm with an extensive supply chain in its procurement process, whereas a small firm may easily identify all factors and costs.

A typical procurement process consists mainly of acquisition costs, but the wood procurement process is complex and includes all three categories rather than just accusations. Moreover, since the procurement process depends on the supplier's relationship, it becomes necessary to manage those relationships in a prosperous way to optimize the different costs categorise.

3.4 Supplier relationship management

Heizer *et al.* (2017) writes that most firms' costs consist of a large extent of the procurement costs, whereas the price and the supplier relationship have an impact. Therefore, combining efforts to reduce costs and managing supplier relationships can improve competitiveness for all partners within a supply chain. Furthermore, promoting collaboration to create value for all parties results in lower costs, reduced risk, greater efficiency, better quality, and access to innovation. SRM consists of five main components, which all are briefly described in table 4.

Table 4: The main components of supplier relationship management (Heizer et al. 2017:147)

Component	**Definition**
Organizational structure	Implementing SRM at a corporate level is meant to coordinate SRM activities between different business units.
Governance	A governance framework that defines which supplier activities to engage in is necessary for an effective SRM. Segmenting suppliers in a governance framework can be done by the supplier’s potential value, risk or cost.
Joint activities	Engaging with the suppliers and conducting joint activities is crucial for a good relationship with suppliers.
Value measurement	Practicing SRM makes it possible to measure and compare values created from a supplier relationship.
Systematic collaboration	SRM enlarges possible interaction activities between a supplier and a customer beyond monetary and material transactions.
Technology and systems	Digital solutions to gather data and perform objective analyses on the supply chain are preferable to identify problems, performance, and improvements.

SRM within wood procurement is crucial since the wood resource is limited to a limited amount of suppliers. Being transparent, reliable, and effective as a wood purchaser is crucial for a supplier’s trust. Not meeting the forest suppliers' demand may lead to significantly higher procurement costs or not being able to procure any material. Including SRM in this study is essential to asses if harvest measurement improves or worsens the relationship to the supplier.

3.5 Activity-based cost - analysis

Activity-based cost analysis aims at identifying cost pools, categorized by activity, to allocate overhead costs. ABC analysis differs from traditional costing methods in how overhead costs are assigned to a service or product. Overhead costs are expenses that cannot be identified with any specific cost unit. Direct costs are, as in traditional costing methods, still applied directly to the product or service. Cost pools refer to a set of activities necessary to perform a certain task. ABC also aims at identifying cost drivers which cause the associated cost to appear within each identified activity. By assigning overhead costs for each activity and divide the estimated level of activity for each cost driver, a predetermined overhead rate may be identified. The predetermined overhead rate can then be used to allocate overhead costs to products or services. Figure 4 provides an example based on Kotzab *et al.* (2010) ABC framework for forest-related supply chains.

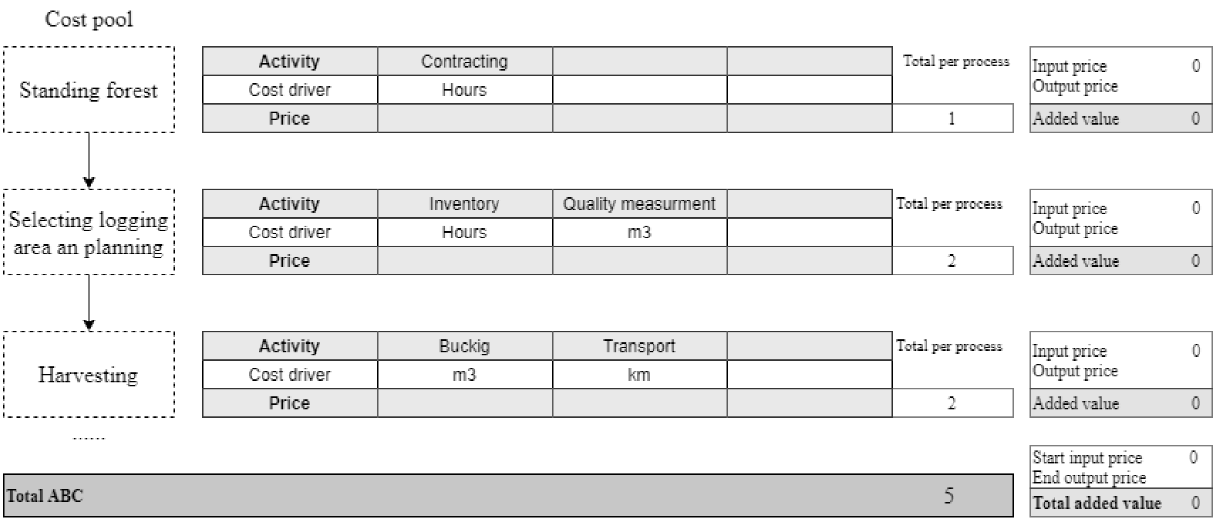

Figure 4: The activity based cost analysis framework by Kotzab et.al (2010:836).

This study used an ABC framework, based on the one presented by Kotzab et.al (2010), to organize cost pools by each activity and identify the cost drivers. Each cost was also assessed by applying theories from total cost of ownership to understand the complexity of wood procurement better.

3.6 A conceptual framework

A conceptual framework was constructed to fulfill the aim of the study, based on the literature review and selected theories. Furthermore, the study was divided into three steps illustrated as the conceptual framework in figure 5. The steps are a fundamental understanding of the concepts, map the process and analyze the process.

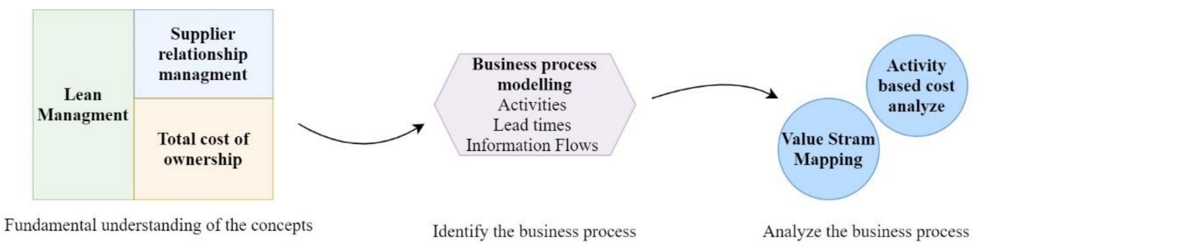

Figure 5: The conceptual framework for this study and how the different parts connect with each other.

Theories of lean management, total cost of ownership, and supplier relationship management provide the fundamental understanding of the concepts. The combination of the theories provides an understanding of the conditions within a procurement process, what factors affect it and what must be done to achieve a more efficient process. The fundamental understanding supported in assessing the harvest measurement contribution to the procurement process. With the help of a value stream mapping, business process modeling was used to identify, analyze, and illustrate the procurement process with industry measurement and how it differs from harvest measurement. A VSM made it possible to illustrate and analyze the processes to distinguish value-adding and non-value-adding activities. Lastly, an ABC analysis was conducted to determine cost pools and cost drives within identified activities and how harvest measurement affects the procurement costs. Finally, a proposition of a future procurement process was presented based on the findings within the study and recent innovations and developments in wood procurement presented in chapter four.

4 Method

The chapter provides the chosen methods for this study. The chapter begins by providing the research approach followed by the design, unit of analysis, data collection, empirical data analysis, research quality, ethics, and lastly, an illustration of the study's analytical scheme.

4.1 Approach

For the fulfillment of this study's aim, an *abductive* approach was chosen. This study aimed at presenting the wood procurement value chains of industry and harvest measurement. A *deductive* approach aims to test a theory, which would have been suitable if there was a hypothesis of the phenomenon that could have been validated or rejected by *observations*. An *inductive* approach aims at making *observations* to generate a *generalized theory*. Firstly, a study can never be fully *inductive* because humans constantly observe reality in relation to their prior knowledge (Wiedersheim. paul & Eriksson, 1991). Secondly, this study is based on previous knowledge and theories, whereas there is no complete hypothesis of the phenomenon. An *abductive* approach combines both the inductive and deductive approach, where the researcher makes links between the research empirical results and a conceptual framework from which the author eventually draws conclusions (Robson, 2011).

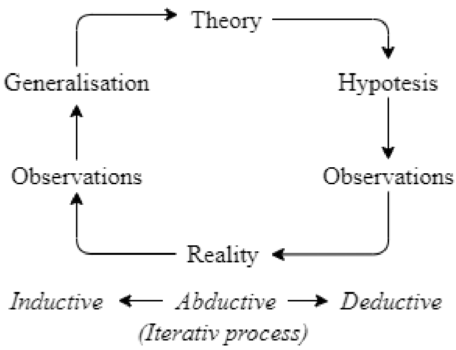

Figure 6. The relation between hypothesis, observation, generalization, and what method it relates to (Wiedersheim-Paul & Eriksson, 1991:208).

This study generated empirical results, and the conclusions are based on a conceptual framework, whereas the whole process was iterative. Additionally, this study used previous research and literature to understand better the analysed empirics, which is also typical for an *abductive* approach.

4.2 Research design

A typical feature of case studies is that data and variables of a *phenomenon* is derived from its *context*, and that it intends to study issues of "how" and "Why" (Yin, 2011). Collection of data within case studies are often done by both qualitative and quantitative methods (Bryman and Bell 2017). Furthermore, a case study is relevant where there is a need for flexibility and adjustability (Robson, 2011). This study intended to have an abductive approach and an iterative process, which makes flexibility and adjustability a requirement for the research design. A single case study intends only to regard one organization or phenomenon to investigate, while a multi-case study make use of several (Yin, 2011). The result from a multi-case may be applied to a wider population in a broader sense, while a single case will provide results for a specific unit but in depth. Furthermore, a multi-case may be chosen when a study aims at identifying differences between individual units rather than producing a general result whereas the uniqueness of the unit is of no interest (Bryman & Bell, 2017).

This research intended to provide a general result for the forestry industry, based on one representative unit, rather than identifying differences between units. Continuously, a depth of the study was required to enable a discussion if harvest measurement improves the procurement process. The specific aims of this study argued for using a single case study, whereas the main reason was to provide a deeper understanding of the studied topic.

4.2.1 Unit of analysis and observation

The *phenomenon* of industry measurement and harvest measurement were the units of analysis for this study, whereas the *phenomenon* was derived from the *context* of wood procurement. The unit of observation for this case study had to be a company that makes use of both harvest measurement and industry measurement in their procurement processes. The chosen unit of observation for this study was Södra Skogsägarna. The choice was made based on the company's strong market position, long experience of both measurement techniques, and being a representative company for the forest industry. The company will be further described in chapter five.

4.3 Collection of data

Qualitative and quantitative data can be derived using either qualitative or quantitative methods, whereas a qualitative method will bring an in-depth insight on a topic, while a quantitative method can help establish generalized facts (Bryman & Bell, 2017). This study intended to identify and analyze activities, information flows, cost-drivers and lead times for a single case in depth, which argues for using a qualitative method. Furthermore, the complexity of the wood procurement process would make a quantitative study very time-consuming, whereas the result may not be significantly greater than what is derived from experienced professionals. Therefore, only primary data was used in the study. Primary data is preferable when there is a need for custom data for a particular theoretical or empirical problem. Primary data also ensure that the collected data is up to date, compared to secondary data, which may be several years old (Bryman & Bell 2017). Though, primary data also requires a level of competence from the research.

This study has collected primary data by performing semi-constructed interviews at the unit of observation with experienced professionals. The interviews were conducted with professionals from the district office of Långasjö and from the industry part of Södra. The order of the interviews was based on previous knowledge about the procurement process, whereas the first interview was with a professional at the beginning of the process and the last in the end. This was due to the assumption that information will start at the beginning of the process. By collecting data of what information was sent and received by whom at the beginning, the interviews later in the process could be adopted to find more fruitful information about the information flows, activities, lead times and cost-drivers.

4.3.1 Semi-structured interviews

Data were collected by conducting interviews with experienced professionals within the procurement process. Collecting data using semi-structured interviews is a common method within case studies where there is a need for flexibility and adjustability (Robson, 2011). Semi-structured interviews often consist of a relatively specific list of topics relevant to the study, often referred to as an interview guide. Interview questions are formulated within each topic and should be constructed to ease answering the study's research questions. (Bryman & Bell 2017; Yin 2011) There is no requirement for the interviewer to ask the questions in a specific order, but the questions should aim to be broad and open at first while still having a direction. Furthermore, the interviewer must be aware of the purpose of the interview and ensure that the interview focuses on the topics of interest. The interviewer must also ensure that the respondent do not move away from the topic, and that there is an adherence within the interview. Adherence within the interview ensures that the interviewer asks questions based on the respondent's previous answers (Yin, 2011).

The interview guide for this study consisted of five themes, whereas each one had a specific connection to the study's aim and conceptual framework. Table 5 presents an overview of the themes and how they relate to the theories and aim.

Table 5: Topic in the interview guide and their link to the study's research questions and theoretical framework

Theme	Related theories	Related aim and RQ
1. General	-	-
2. Activities, lead times & cost drivers	*BPM, TCO, Lean*	Identify activities, lead times and cost drivers. Also aims at identifying non-value adding activities: RQ1, RQ2
3. Information flows	*BPM, Lean*	Identify information flows, and if any becomes non-value adding: RQ1, RQ2
4. Difference in the process of harvest-measurementcompared to industry measurement	*BPM, TCO, SRM, Lean*	Process and cost-benefits of harvest measurement: RQ2, RQ3
5. General advantages and disadvantages of harvest-measurement	*SRM,, Lean*	Explore possible improvements within procurement by using harvest measurement: RQ1, RQ2 and RQ3

The first theme is a general theme where the respondent was asked how long they have been at their current position and what their main tasks are. General questions are asked to get a comprehensive picture of the professionals and how they are involved in the procurement process. The second, third, and fourth themes covered activities, information flows, lead times, cost drivers, and industry and harvest measurement differences. Questions within these themes were meant to identify all activities within the processes, understand them, and eventually analyse them and determine if harvest measurement has process and cost-benefits compared to industry measurement. Concepts and principles within BPM, TCO and SRM were meant to help the author interpret the data, understand the purpose and character of each activity, and further determine whether they are value or non-value adding with the support of Lean management. The fifth theme regarded possible improvements, general advantages, and disadvantages with respect to harvest-measurement that the professional may have thought of. This is meant to support the author when exploring possible improvements within the procurement process when harvest measurement is used. The complete interview guide is attached in appendix 1.

4.3.2 Sampling criteria

Respondents with good knowledge and experience of the procurement process was required to ensure a reliable answer for the study's research questions. Respondents was selected by a non-randomized approach, whereas requirements were established for the selection of respondents. The choice of a non-randomized selection was argued by this study's intention to provide in-depth knowledge of a specific business process. A non-randomized selection is necessary whenever there is a need for fruitful and specific data, whereas a randomized approach is suitable when there is a need for a public opinion rather than specific data about a business process (Bryman & Bell, 2017). Table 6 presents the respondents' requirements for this study.

Table 6: Selection criteria of the respondents and how this study intends to ensure that the requirements are fulfilled

Requirement	How the study fulfilled the requirement
• *Involved in the procurement process* • *Understanding of their inputs and outputs* • *A perception of cost and cost drivers* • *A perception of time required for each activity*	By a non-randomized approach and a consultation with Roger Andersson from Södra business innovation.
• *Willing to participate*	By asking the respondent to participate and clearly inform about the intention of the study.

The requirements of the respondents were established to ensure the reliability of the collected data. First, the respondents had to be involved in the procurement process and understand their collected inputs and produced outputs. An understanding of the inputs refers to the respondents understanding why and from whom he collects or receives specific information and data. An understanding of the outputs refers to the similar requirements and why and to whom he sends specific information and data. Furthermore, the respondents had to have a perception of costs and cost drivers within his area for the study's ABC-analysis to fulfill the aim regarding cost-benefits. Continuously, the respondents had to be willing to participate in the interview. The requirements were fulfilled by interviewing experienced rather than novice professionals, assuming that a professional will not have a complete understanding of their working task until a few years of experience.

Furthermore, several respondents from the same area are necessary to ensure saturation of collected data. Saturation refers to when no more or new data is received by conducting another interview (Bryman & Bell, 2017).

4.3.3 Selection of respondents

Respondents was selected by a non-randomized approach and by a consultation with a professional from Södra's business innovation section to ensure that the respondents fulfilled the requirements. Three respondents from the district office of Långasjö, two professionals from the Södras industries, and one professional at Biometra was interviewed. Table 7 summarizes the interview respondents and the order the interviews were conducted.

Table 7: The number of respondents, their position and where they are situated

Respondent	Position	Office or area	Date and duration
A	Forestry inspector	Distric office Långasjö	2021-04-09 (1:h)
B	District manager	Distric office Långasjö	2021-04-09 (45: min)
C	Production planer	Distric office Långasjö	2021-04-12 (45: min)
D	Project leader	Södra industry	2021-04-12 (1:h)
E	Bucking specialist	Södra industry	2021-04-13 (45: min)
F	Service developer	Biometria	2021-04-15 (2:h)

The last interview was conducted with a professional from Biometria to fill knowledge gaps regarding technical steps in the procurement process that had appeared in the research process.

4.4 Method for the analysis of the empirical data

4.4.1 Value stram mapping

A value stream map was conducted to comprehensively illustrate activities, information flows, and lead times within the procurement processes. The VSM gives an overview of the process with estimated lead times from the respondents and the total time required for one process cycle. Considering the complexity of a wood procurement process, a detailed mapping of the process is beyond the time limit for this study. Instead, this VSM presents the overview and estimated time requirements for the process, which will contribute with knowledge to where further investigations should be made. The idea of conducting interviews with all participants within the process was to identify waste in terms of unnecessary information and non-value-adding activities when using harvest measurement instead of industry measurement. This study can then argue for process- and cost-benefits with harvest measurement based on the VSM combined with the conducted ABC analysis.

4.4.2 Activity-based cost analysis

An activity-based cost analysis was performed to present the cost differences between the wood procurement processes. The purpose was to enable a reasoning whether harvest measurement brings cost-benefits for the procurement process or not. The analysis was performed by categorizing activities into cost pools from the interviews. After that, cost drivers was assigned to each activity within each cost pool. The total number of activity-related costs within each process was then be counted, and the corresponding cost of each could be estimated. The estimated cost within each cost pool can then be summarized to present an estimated cost difference between industry and harvest measurement. Figure 7 illustrates the constructed framework for this study's ABC analysis, which is based on Kotzab *et al.* (2010) ABC framework for a forest supply chain. This study did not acquire price values for each activity from the interviews due to the observation unit's confidentially rules.

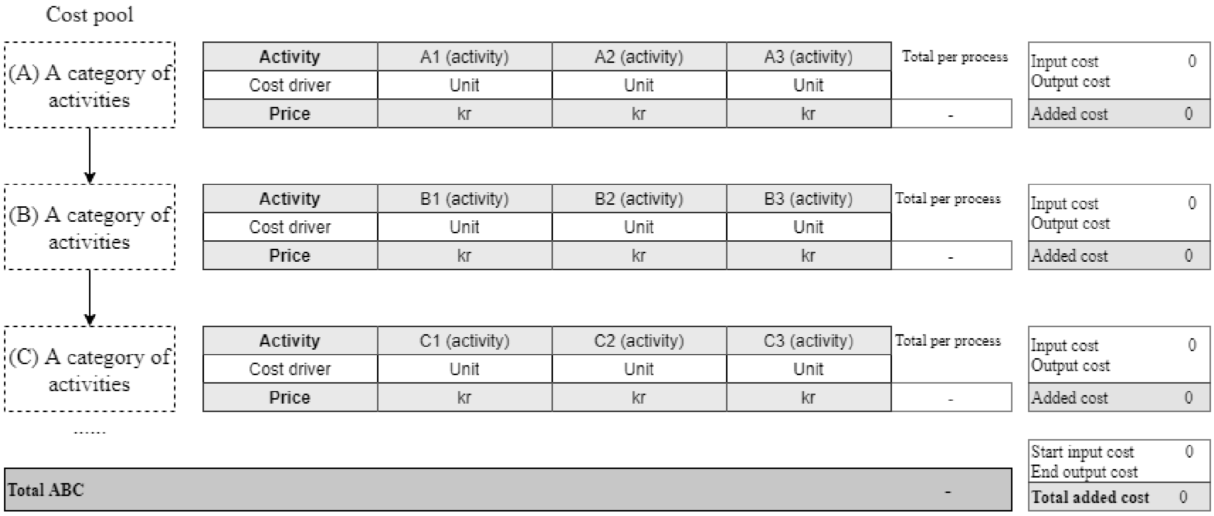

Figure 7: The ABC framework constructed for the analysis of cost within the procurement processes.

Total added cost in the framework refers to the total cost that appears within the process. The iterative process of the study supported in finding all present activities and their cost drivers. Furthermore, the complexity of the procurement process and the time limit for this study argued for collecting qualitative data of the cost drivers from the interviews instead of analyzing quantitative data from the case company for each activity. This entails that the study only presents an overview of costs based on the professional's experience rather than statistically confirmed values. Lastly, this study intended to estimate the cost of each activity. Data for this was collected using published data from Skogsstyrelsen, Skogforsk, Södra Skogsägarna and information from the previous CEO of Biometria. The purpose is to present an estimated monetary gain per cubic meter when procuring wood with harvest measurement instead of industry measurement.

4.4.3 Improvements

Improvements within the procurement process were discussed for the fulfillment of the third research question. The obtained comprehensive understanding of the process, combined with research on recent technical developments from the empirical background and the support of studied principles of Lean, suggestions on process improvements could be stated. Improvements refer to the reduction of performed activities, information flows, lead times and costs in the procurement process.

4.5 Delimitations regarding the method

A case study will only generate a result that can be generalized in an analytical sense and not on a whole population (Yin, 2011). Yin (2003) distinguished between five different cases, whereas a representative case is meant to analyze a typical organization. This particular study intended to make use of a representative case rather than finding a unique case. With respect to the scope of this study, the collected data is unique for the single units observed within the representative organization. The scope of the study did not allow for a complete analysis of the whole organization, nevertheless the whole industry. However, the approach of this study to identifying activities, information flows, and lead times can be applied for other units within the organization as well as other organizations in the sector. Therefore, the specific case of this study can be used as an example of how to analyze the wood procurement supply chain for other organizations or other units within the observed company.

4.6 Research quality assurance

Bryman and Bell (2017) discuss whether the terms *validity* and *reliability* are relevant for quantitative research and refer to Mason (1996). Mason (1996) argues that the terms, combined with *generalizability,* are "different kinds of measures of the quality, rigor and more general research potential that are achieved on the basis of certain methodological and subject-related conventions and principles." Mason (1996) favors using the terms in qualitative research, whereas Guba and Lincoln (1994) argue that the terms may be used in quantitative research but not in qualitative. Guba and Lincoln (1994) propose criteria of *trustworthiness* to ensure research quality in qualitative research. Principles from Guba and Lincolns (1994) criterion of *trustworthiness* was used to ensure the research quality of this study. The principles of *credibility, dependability, confirmability,* and *transferability* and how they were applied in the study is presented in table 8.

Table 8: Principles from Guba and Lincolns (1994:257) criteria of trustworthiness and their application in the study

Principle	Description	Application within the study
Credibility	The principle entails that participants and their contributed empirical material must be correctly retold.	The respondents confirmed through feedback that the gathered material was correctly understood and correctly reproduced in the study
Dependability	Dependability considers that the research must be independent of the researcher.	The number of respondents, their geographical position, time of the interviews and the respondents' professions are accounted for in the study, as well as the research method.
Transferability	Transferability suggests that a complete and transparent accounting of all different steps within the research should be made to make extrapolation possible.	Aim, research questions, applied theory and method with motivation of chosen unit of analysis and observation is accounted for within the study.
Confirmability	Confirmability entails that any researchers should ensure that no preconceptions has affected the result or execution of the research.	This research aims at presenting the collected empirical material with no influence of the researchers' preconceptions of wood procurement. Also, applied theories and methods are accounted for by referring to their origin and why they are relevant for the study. Furthermore, results from this study only originates form the conducted interviews, whereas the coding of these are made by the author's preconceptions based on previous knowledge and the conducted literature review.

Case studies is often performed by collecting data with more than one method (Robson, 2011). This study collected qualitative data by using a single data collection method. But the dependability and transferability of the study ensure that there is no hinder for further research to be made where additional collecting methods may be used to achieve triangulation of the results. Furthermore, using a single method for data collection makes confirmability essential for the study. Only qualitative data were collected from the interview, and the conception of these may be affected by the author's preconceptions. The confirmability is strengthened by the applied theories and methods used, whereas their origin and relevance for the study is argued for. Furthermore, the literature review and introduction present previous knowledge about the topic and phenomena which the author must take a stand on when making the study's conclusions.

4.7 Research ethics

Ethical considerations should be reviewed throughout the whole research process and not just at an endpoint (Robson, 2015). Informed consent regards if participants know in advance what the study will involve. Respondents in this study were therefore informed of the study's aim and outline, how their data would be used in the report, and that the study would be published. The respondents were also informed that they could end the interview at any times, as well as withdraw their approval to participate. Lastly, ethical considerations were made when informing the respondents that the collected data throughout the interviews is only used for answering the aim and research questions of this study.

4.8 The study's analytical scheme

This case was conducted through a series of steps, whereas the order and relation between the steps are illustrated in figure 8.

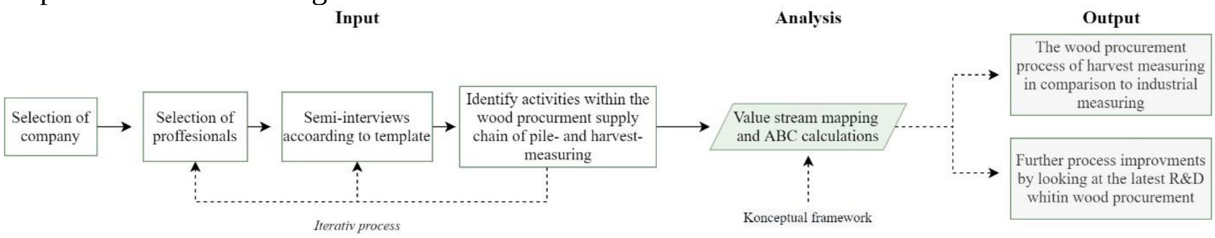

Figure 8. An illustration of the case study's analytical scheme.

First, a selection of a company was made based on the study's requirements for generalization. Secondly, professionals were selected according to the requirements stated concerning their work relevance and experience. Thirdly, semi-interviews were conducted according to the constructed interview guide, and activities etc. are identified. Continuously, the data was analyzed and presented using a VSM and ABC-analysis with support of the study's conceptual framework. Lastly, the output of the study generated answers to the aim and research questions.

5 Empirical background

This chapter aims to present the reader with a description of the value stream of wood, how the different measurement techniques work, and recent research and developments within wood procurement.

5.1 Value stream of wood

The value stream of wood from plant to tree, to finished product, spans over decades and requires several steps. The Swedish model is based on planting, followed by one or several pre-commercial thinning, thinnings, and ends with the final harvest where timber and pulpwood are gathered. Figure 9 illustrates a general value stream of wood, based on the supply chain of this study unit of analysis, Södra Skogsägarna, who owns pulp mills, sawmills, and heating plants, and procure their wood from their members and external suppliers.

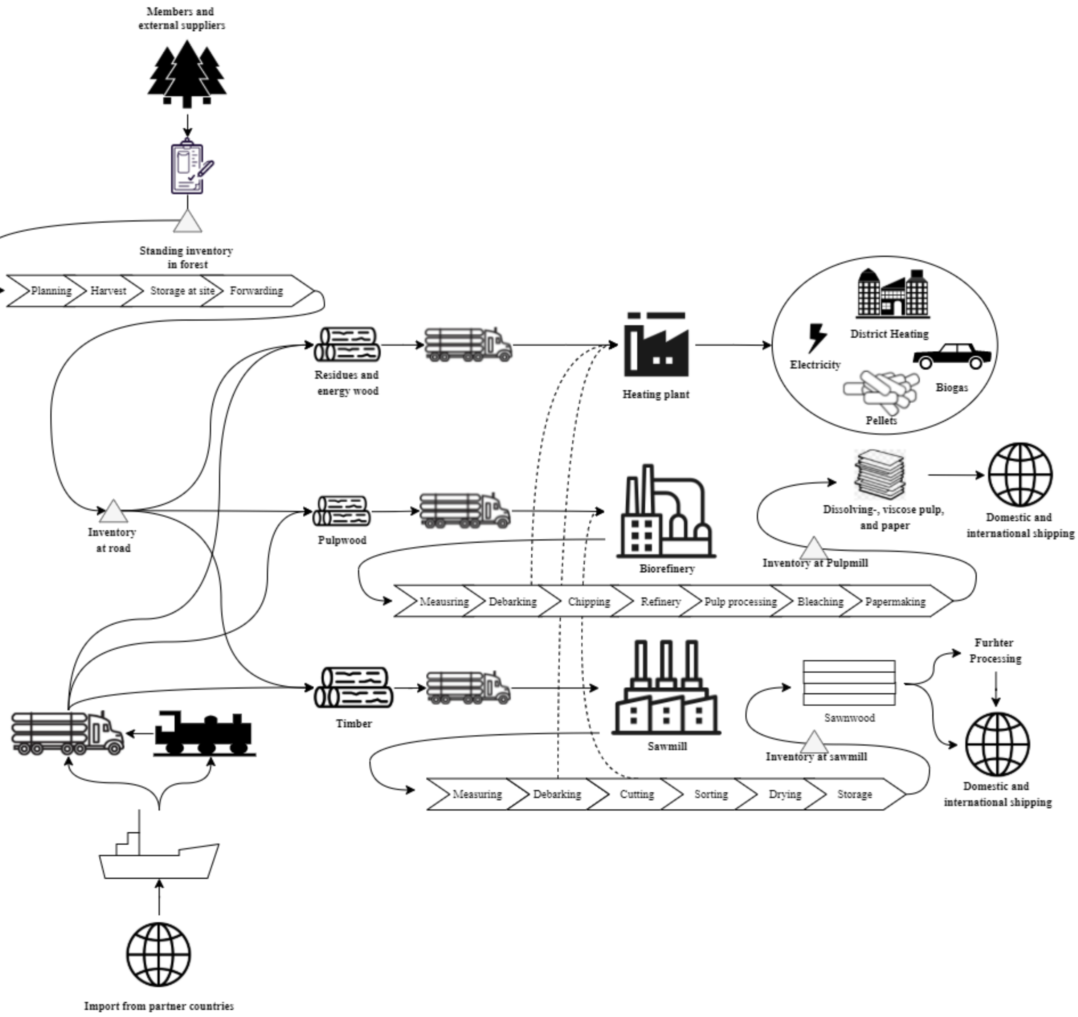

Figure 9: A typical value stream of wood for a forest association or company.

Wood is procured from the members in the case of Södra, which is harvested and transported to the different industries where different processes take place to turn the wood into finished products sold at the domestic and global market.

This study focuses on the value stream from the contract with the supplier until the wood reaches the industry. Figure 10 presents a schematic illustration of that value stream, with basic information and material flows between the different partners in the stream.

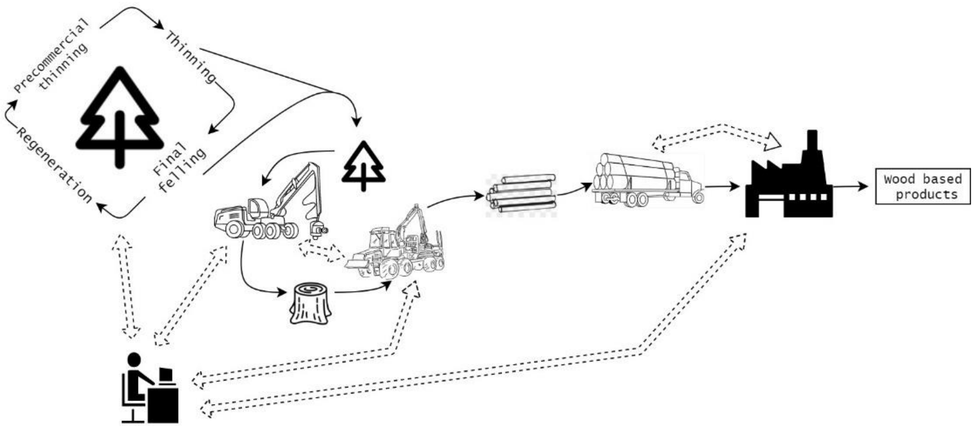

Figure 10: Detailed value stream of wood from supplier to end customer, including material flows and information flows.

This study focuses on identifying the differences in this value stream when two different measurement techniques are used. Industry measurement takes place at the industry, whereas harvest measurement takes place during the harvest. The two techniques are explained further in the following chapter.

5.2 Industry and harvest measurement

5.2.1 Measurement points in the value stream

Industry and harvest measurement are the two different measurement points in the value stream that this study intends to analyze. Industry measurement refers to measurements of roundwood taken at the industry connected to the sawmill or pulpmill. These measurement techniques could either be log-to-log or pile measurement and requires a certified supervisor. Harvest measurement refers to measurements taken by the harvester's harvester head, which requires qualified machines and certified operators (Wilhelmsson *et al*, 2019).

5.2.2 Assortment and stem-price list

Assortments price lists are used in contracts where industry measurements act as a payment basis, whereas stem-price lists are used in contracts where harvest measurement act as a payment basis. Assortments price lists are a list with specific prices for roundwood with different diameters, lengths, and quality. These price lists are often complex with a wide range of different assortments, whereas the unit also can differ between cubic meter under bark and cubic meter top measured, for instance. Due to the complexity of an assortment list, the average cubic price can be difficult to determine, making a comparison between different price lists difficult (Wilhelmsson *et al*, 2019). Stem-price lists provide a single price for the measured volume, based on the species, diameter in breast height, and the quality, regardless of how the wood is cut-to-length, not specific prices for certain lengths. This makes it easier to compare stem-price lists with one another (Södra, 2017).

5.3 Recent research and development within wood procurement

Recent investments have been made to improve forestry management plans to consist of higher quality and have a more digitalized profile (Öster, 2021). The committed research from these investments is meant to improve the usage of laser scanning's, geographical data, and measurements from the harvester. The intent is to make plans more accurate and include more accurate data on the forest. Also, the digitalized plans enable an automated planning process since forest machines of today have enough advanced tracking systems, which have already been applied and commercially tested by different forest actors.

Virkesbörsen (2021) is a new digital platform that acts as an independent digital market for selling and purchasing wood. This platform enables the purchaser to reduce his time spent on finding suppliers since no physical meeting is required. Combining improved forest management plans with digital market platforms could lead to a new procurement process in the future where no time is spent on finding suppliers or planning in the field.

6 Results

This chapter presents the empirical findings from the conducted interviews. First, a value stream map with industry measurement is presented. Then, a value stream map with harvest measurement is provided. Lastly, an activity-based cost analysis is conducted, followed by quantification of the found differences.

6.1 Value stream of the procurement processes

Figure 11 on page 27 visualizes the procurement process with *industry measurement* based on the collected data from the interviews. The procurement process with harvest measurement and the differences in terms of activities, lead times, and information flows are presented after the process's presentation with industry measurement. This thesis has been limited to the first transaction between the supplier and the procuring organization. There is also a second transaction between the procuring organization and the industry, which this thesis does not consider. The following subchapters 6.1.1 – 6.1.7 describe each step of the process in detail.

6.1.1 Contracting

First, a contact between a forest inspector (buyer) and a forest owner (supplier) is established. This contact may be initiated by the supplier who wants to sell wood or by the inspector who wants to buy wood. Incoming information for this process is the suppliers' values, wishes, and terms for the deal, whereas the inspector from the local office provides forest management suggestions and contracting terms. Both parties agree on which sites to harvest or thin, and additional sub-contracts such as planting, soil scarification and precommercial thinning. General planning is often also conducted where the site borders, roads, and road storage position are discussed. How long the contracting process takes varies from a few to several hours, or in some cases, days. If the contracting terms imply industry measurement, the value of the wood will be settled with an assortment price list, while harvest measured volume is valued by a stem-price list.

Once the contract is settled, there will be an inventory of standing trees. This inventory lasts for about four months, depending on the demand from the industry. A standard contract allows the inventory time to be two years. The risks during this inventory time are mainly storms, fires, and bark-beetle attacks.

6.1.2 Planning

The planning process is mainly initiated by a demand from the industry which matches the site. Road type, site borders, machine routes, environment, and culture-relic considerations are the main things marked in the field by the inspector during the planning process. This process may take one to several hours or days, depending on the size of the contract. Once the process is completed, a digital signal will be sent to the local office internal system that the site is planned and ready for harvest, which the production planer receives.

A second inventory time in terms of standing forest takes place after the planning. The difference is that the site is planned and ready for harvest and may be harvested at any time. This inventory time may vary depending on the situation, if there is a high demand from the industry or if the supplier wants the site to be harvested immediately to prevent insect attacks. This inventory time is about one week.

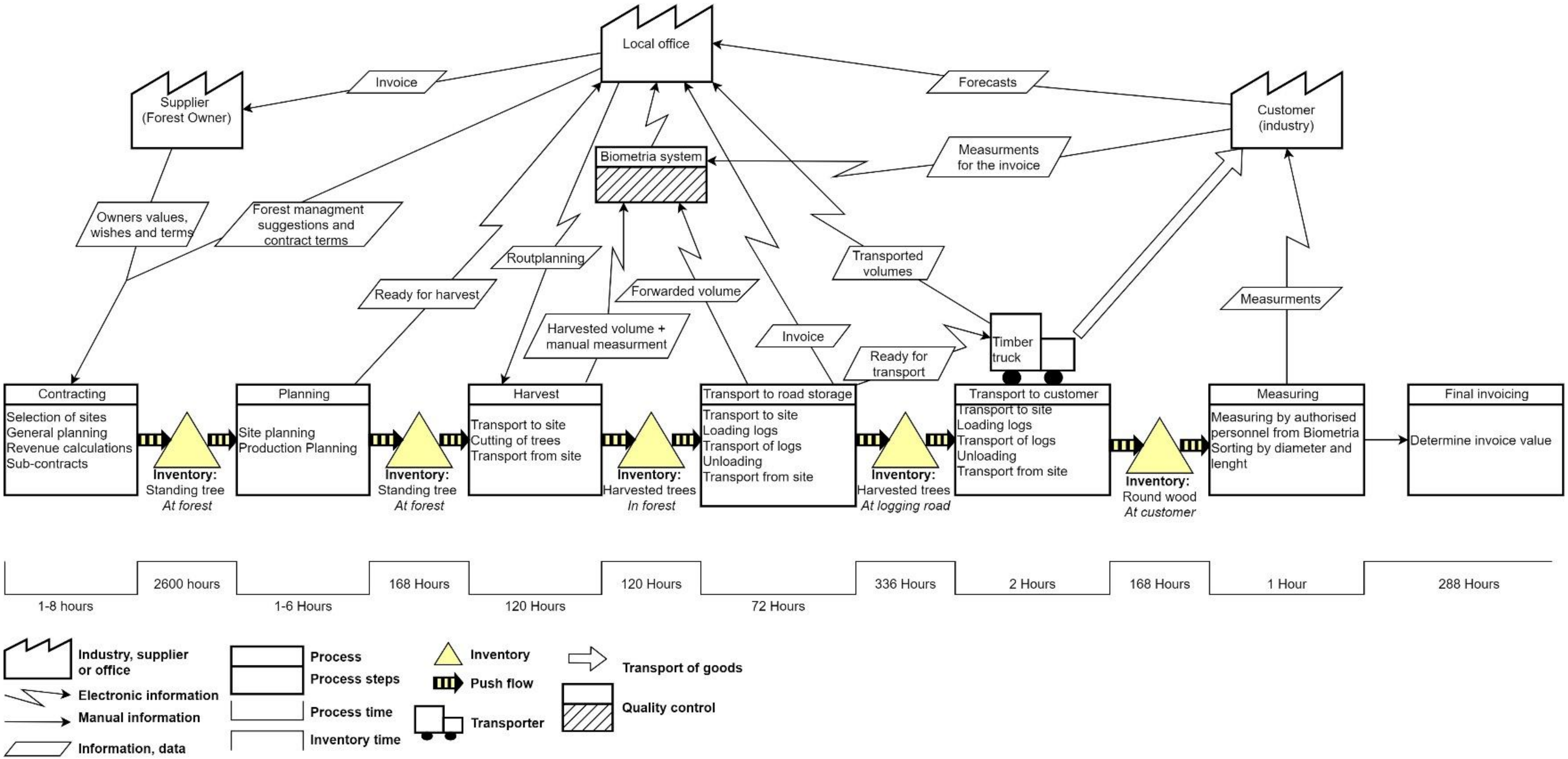

Figure 11: Value Stream of the wood procurement process with industry measurement

6.1.3 Harvesting

The harvesting process is initiated by the production-leaders route planning, which sends a digital signal to the harvester group that it is time to harvest a specific site. The harvester is then transported to the site, and the harvesters start harvesting. Data of harvested volumes is sent every third hour through the Biometria-system to the local office during the harvest. This data is meant to help the local office keep track of harvested volumes and how many harvested trees there are stored in the forest, and the assortments. In addition, the harvester operator is obligated to make manual measurements of sample trees once a day. This is done with a tree caliper and a measurement band. The reason is to ensure that the harvester-head is measuring the trees correctly. Once the harvester has left the site, the harvester process ends. A harvester process may take hours to several days, depending on the type of contract and conditions of the site. An estimated average time for a harvester process is five days.

After the harvester process, inventory in terms of harvested trees in forest occurs. The inventory ends once the forwarder arrives at the site, about three days after the harvester. Thus, the harvester and forwarder process may happen simultaneously, whereas the inventory of harvested trees in the forest becomes very short. Biological decay and missed roundwood by the forwarder due to snow are the main risks during this inventory step.

6.1.4 Forwarding

When the forwarder arrives, the forwarding process starts. The forwarder transports harvested roundwood from the harvested site to the road storage. The forward operator reports forwarded volumes once a day, or for each load. Reported volumes will enter the Biometria-system and be transferred to the local office. Forwarded volumes will also be sent to the transporter that is connected to the harvester group. The information will be autogenerated to a transport route for the trucks. Once the forwarder has transported the last roundwood, he makes a final mark telling the local office and the transporter that the process is completed. The operator will send an invoice to the local office after the process is completed. It may take up to a week for the operator to send the invoice after completing the process. The transport leader receives the invoice and completes the final invoice to the supplier once he receives the measured volumes from the industry.

An inventory in terms of harvested trees at road storage takes place after the forwarder process. This inventory lasts for about two weeks, depending on the demand from the industry, road conditions and the supplier's demand to transport the roundwood. The inventory time ends when the transporter arrives and transports the roundwood to the industry. The risk during this inventory is stolen roundwood, biological decay, forgotten storage, shrinkage, and insects attacks. These risks are considered as low.

6.1.5 Transportation

The transportation process begins when the timber truck arrives at the road storage, where he will load the stored roundwood. The truck will then drive to the sawmill, where the roundwood will be unloaded and either stored at the industry or put in the measuring station immediately. If the roundwood is stored, it must be separated by supplier to prevent mixing. This is since the supplier's payment is determined by the measurements taken in the measuring station.

The storage time at the industry varies from no time to several weeks depending on the demand from the industry's end customer. A rough average time is 2 weeks. Main risks during this inventory step is biological decay and fires, though the risk is low.

6.1.6 Measurement

Lastly, the measurement process where the roundwood is measured and sorted is performed. This process is operated by personnel from Biometria. Roundwood from different suppliers cannot be measured simultaneously. Therefore the operator must separate roundwood from different suppliers, which takes roughly two to three minutes. The measured volume and assortments will be sent through the Biometria system to the local office. Roundwood will be sorted in the sortation section directly after the measuring station.

6.1.7 Final invoicing

Once the measured volumes and assortments have arrived at the local office, the volume value will be added to the invoice from the harvester and forwarder to determine the payment to the supplier. The invoice already has a preliminary result from the reported volumes from the harvester, but since those measurements are not valid in a contract based on industry measurement, the invoice must be adjusted according to the volumes from the measuring station. The final invoice is calculated by the production leader who may send it to the forest inspector before he sends the invoice and the payment to the forest owner. The office has about 12 days to finish the invoice. Once the invoice and payment have arrived at the supplier, the procurement process is finished.

6.2 The procurement process with harvest measurement

Figure 12 on page 31 presents the procurement process with *harvest measurement.* The figure will be followed by an outline of the differences with industry measurement in terms of activities, led times, inventories, and information flows. Red marks in the figure indicate that the activity, information flow, or lead time is performed differently, whereas orange marks present a short description of the difference.

6.2.1 Differences in terms of activities and inventories

Contracting, harvesting, inventory at logging road, inventory at the industry, and the final invoicing, are performed differently or can be performed differently when using harvest measurement. Measurement at the industry becomes non-value-adding since the measurements are already taken during the harvest. The differences and why they occur are presented below.

Contracting
Contracting becomes easier and more transparent. This is since it is easier to explain a stem-price list than an assortment list. Furthermore, the stem price lists are more transparent since it requires much less knowledge to understand compared to an assortment price list.

Harvest
The harvest includes more manual measurements, higher expectations and improved working morale, more responsive bucking, higher harvesting costs, and the inspector receives fewer phone calls during the harvest. More manual measurements are required since the harvester head must achieve a higher measurement accuracy. Expectations are higher on the harvester operator since the measured volume will determine the supplier's income, but that seems to lead to higher workers morale, according to the respondents. The operator receives specific bucking instructions to meet the industry’s demand. Since there is no assortment list that needs to be adjusted with changing demand from the industry, bucking instructions can be changed instantly, making the bucking more responsive to changing demand. Lastly, the inspector receives fewer phone calls from the supplier when the harvest takes place since they don’t have to worry about the wood not reaching the industry.

Inventory at logging road
Whitin the inventory at logging road there are an improved flexibility in the transport flow, improved usage as inventory and longer inventory time. The flow from the logging road becomes more flexible since the wood does not have to reach the measuring station at a certain time to fulfill desired lead time between harvest and the point the supplier receives its payment. The flow from the logging road can also be adjusted better to match the industry’s demand for the same reason. Usage of the inventory may increase in terms of longer inventory time to ease the stress on the inventory at the industry and since there is no need to push the flow to achieve desired lead times

Inventory at industry
Less space is needed for the inventory at the industry. This is since the volume of wood for specific suppliers are already determined at the harvest, there is no need to separate loads from different suppliers at the industry.

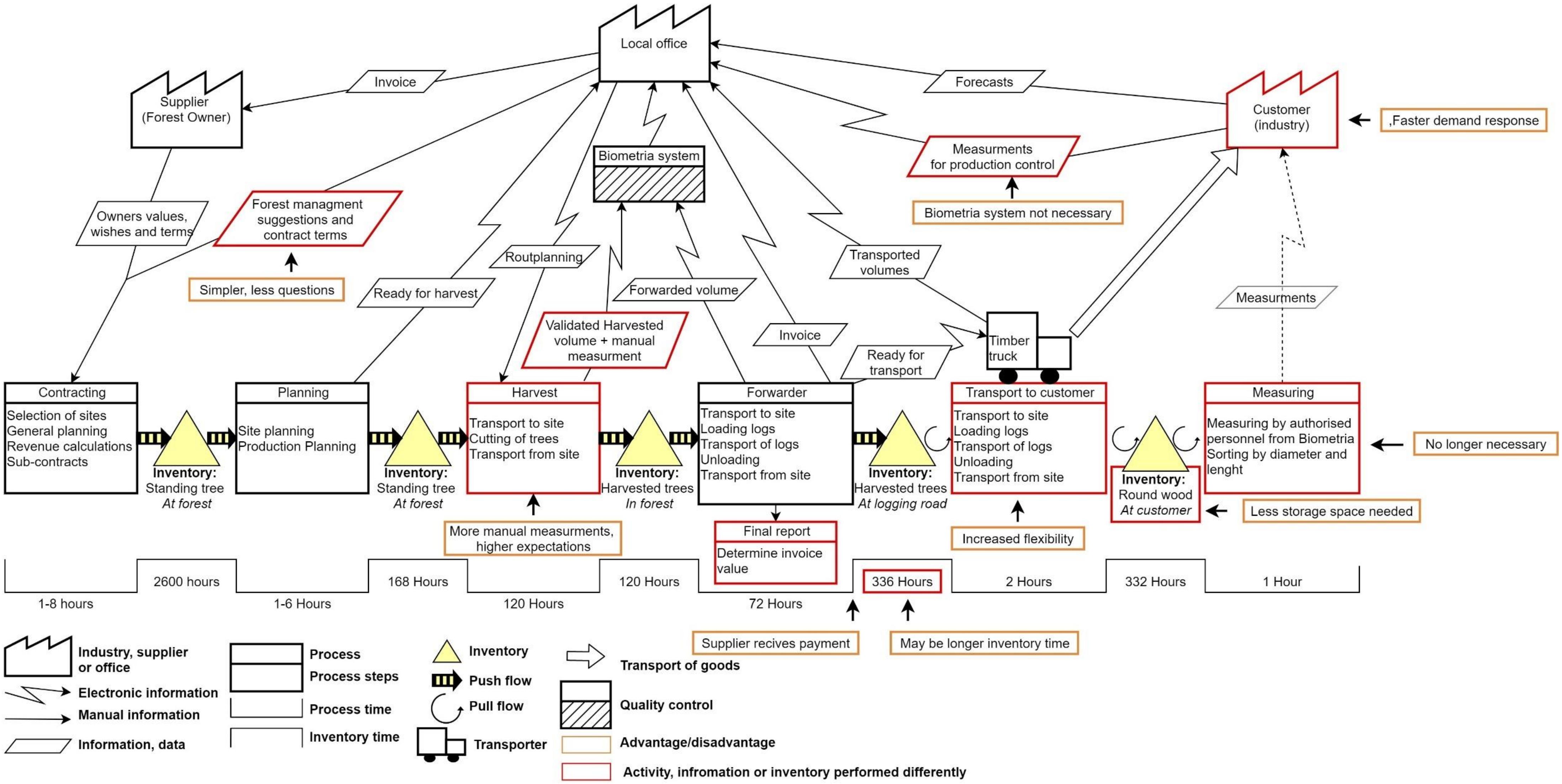

Figure 12: Value stream of the procurement process with harvest measurement.

Measuring at the industry
Measuring at the industry becomes a non-value adding activity, and since there is no need to separate roundwood from different suppliers, less time is then required for the sorting of roundwood. It becomes non-value-adding since the invoice already has measured volumes from the harvester, there is no need to use measured volume from the measuring station. Because the roundwood from different suppliers no longer need to be separated, the sorting right after the measuring station can be done fast and increase the sorting capacity by 15%.

General (Unspecific)
General differences not related to specific activities in the VSM are that price adjustments for assortment lists become unnecessary, and better cash flow for the supplier, worse for the purchaser. Making price adjustments for the assortment's lists is time-consuming and becomes unnecessary using stem-price lists with a fixed m3ub price. Since the invoice already includes reported costs from the harvester and forwarder and the measured volumes from the harvester, there is no need to adjust the invoice with measured volumes from the measuring station (If any).

6.2.2 Differences in terms of risks

With industry measurement, the supplier takes all risk in the value stream since he owns the roundwood until it reaches the measuring station. Therefore, everything that happens between the harvest and the measuring station will affect his payment. In contrast, the buyer takes all the risks with harvest measurement since he owns the roundwood once it is harvested. Therefore, there is no risk of forgotten-, stolen-, shrunken- or biodegraded roundwood taken by the supplier. Neither does he take any risk if the operater cuts the trees with a margin of error, if a harvester cuts to the wrong price list, if roundwood is not separated at the industry correctly, if the forwarder separates assortments faulty at the road, or if there is any administrative mistake done in the value stream.

6.2.3 Differences in terms of Lead times

The district office mainly monitors time from contract to harvest, time from harvest to supplier receives payment, and time from forwarded roundwood to transport, to ensure a preferred safety inventory at the road and maintain a good relationship with the supplier. Ideal lead times and differences between industry and harvest measurement are presented below. Lead time from signed contract to supplier receives payment is also monitored.

Time from contract to harvest
The ideal time is about four months to ensure not too much standing inventory in stock and not to small stock. No difference between harvest or industry measurement.

Time from harvest to supplier receives payment
The ideal time from harvest to supplier receives payment is no longer than two months to ensure a good relationship with the supplier. Harvest measurement shortens this led time to about four weeks as illustrated in figure 13. The reason is that the invoice can be completed without having to wait for reported volumes from the measuring station. The production leader only has to wait for the reported costs from the harvester and forwarder.

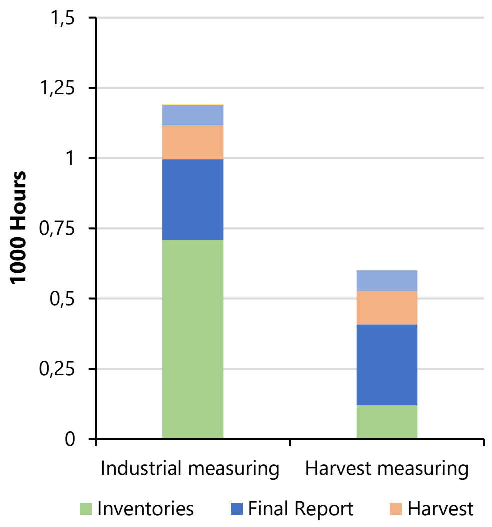

Figure 13: Lead time from harvest to the point when the supplier receives his payment.

Time from forwarded roundwood to transport
The ideal time is two to two and a half weeks to reduce the risk of biodegraded roundwood. According to the respondents, this might be prolonged since there is no stress to reach the lead time for the payment to the supplier because it is not dependent on when the roundwood arrives at the industry. No qualitative data of specific times for this lead time when using harvest measurement was collected in the interviews.

Time from contract to suppliers receives payment
The lead time from contract to the point when the supplier receives his payment illustrates that there is also a significant difference between these steps, illustrated in figure 14. According to the respondents, this time should is about six months for industry measurement, and is reduced to about five and a half months with harvest measurement.

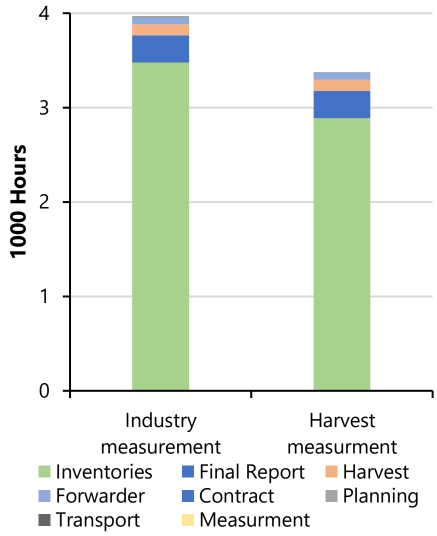

Figure 14: Lead time from contract to the point when the supplier receives payment.

The leadtime from harvest to supplier receives payment will also not be dependent on the transport to the industry with harvest measurement. Transport is one of the main sources of prolonging the lead time according to the respondents. Some respondents also mention that the lead time from the point a contract is signed to harvest beings may be shorter when using harvest measurement. This is since there is more flexibility in how the harvester can cut the trees, and if there is a change in the demand from the industry, there is no waiting time for a new assortment list to be produced. This may also be expressed as a difference in terms of information flow.

6.2.4 Differences in terms of Information flows

The main differences in information flows in the process when harvest measurement is applied presented below.

Information from measurementstation
Data form the measurementstation to the Biometria system for the invoice and production control is the information flow in the procurement process that disappears when using harvest measurement. This is since there is no data obtained at the station to pass on to the industry. Also, the information flow between the industry and the district office does not have to go through the Biometria system anymore because the volumes are manually reported and not used for the invoice to the supplier.

Bucking instructions
Information flow of bucking instructions for the harvester operator may work more efficiently since there is no need to construct an assortment list. That is because the stem-price list is not dependent on the assortments taken out during harvest. The information flow is digital in both cases, but the information it contains can be produced and sent faster with a stem-price list and faster meet the demand from the industry.

Contract terms
The manual transferred information to the supplier becomes easier since there is no need to explain the assortment price list. Explaining the stem-price list is easier, and there are less questions asked about during the harvest because the supplier do not need to worry for his roundwood since it is already measured.

More information from the harvester
Reported volumes from the harvester to the district office will include validated volumes that will determine the payment to the supplier. This information flow is crucial in both cases for the district office. The information flow also becomes crucial for the supplier when harvest measurement is applied, this is since their payment will be based on the measured volumes by the harvester. Also, more manual measurements are included in this information flow that Biometria will assess to ensure that the machine is measuring correctly.

6.3 Waste within the procurement process

When comparing the wood procurement process of harvest measurement with industry measurement, most types of Muda waste described by Heizer *et.al*, (2017) can be identified except for overproduction and excess stock. The main waste of processing and waiting that appears are due to the measuring station being non-value-adding when using industry measurement. What type of wastes and how they appear in the process are described below.

Waiting
There is no need to stop at the sorting station to separate loads from different suppliers, hence less waiting waste. Separating loads from different suppliers takes about 3 minutes. Since that

is done multiple times during a day, the capacity in the sorting station could increase by 15% when using harvest measurement, according to the respondents.

Transportation

Transportation waste may be reduced when using harvest measurement since the transport becomes more flexible. Transport planning can be done without having to consider the lead time from harvest to supplier receives payment. The transport flow can also be arranged differently since there is no need to separate roundwood from different suppliers, whereas transportation waste in terms of time and fuel might be reduced.

Processing

Harvest measurement enables more flexibility in adjusting the processing of trees to meet the customers' demand, which reduces unnecessary processing where trees are cut according to an assortment list that may not be optimal for the current demand. This is since stem-price enables the operator to cut the tree in any length without affecting the supplier's payment.

Unnecessary motion

The unnecessary motion to adjust the invoice by the production leader is reduced since there is no reported volumes from the measuring station to adjust with. According to the respondents, seven out of ten invoices must be calculated and adjusteded. Also, the respondents mention that there is no need for the invoice to pass by the production leader before it arrives at the inspector who sends it to the supplier.

When the forest inspector does not have to explain the assortment-price list for the supplier, unnecessary motion is saved since the inspector does not have to take his time and explain it. Also, the respondents state that the inspector receives fewer phone calls from the suppliers during and after the harvest. This is because the measurements have already been taken during the harvest, and the supplier does not have to worry about biodegraded or forgotten roundwood.

Mistakes and defects

The harvest operator makes less waste in terms of mistakes and defects when using harvest measurement since the operator must conduct more quality controls. Sawmills require roundwood at a specific length to meet their customer’s demand. If a harvester is faulty calibrated, it might cut too long or too short roundwood, which wont be noticed until they arrive at the industry. Since harvest measurement requires more manual measurements to check how well the machine is calibrated, less mistakes and defects are believed to be made.

6.4 Summary of differences

Chapter 6.2 and 6.3 is summarized in figure 15. The figure illustrates what inventory or activity associate with what difference and if the difference affects the process in terms of less waste. Figure 15 presents a diagram of 20 differences obtained from the interviews with the respondents.

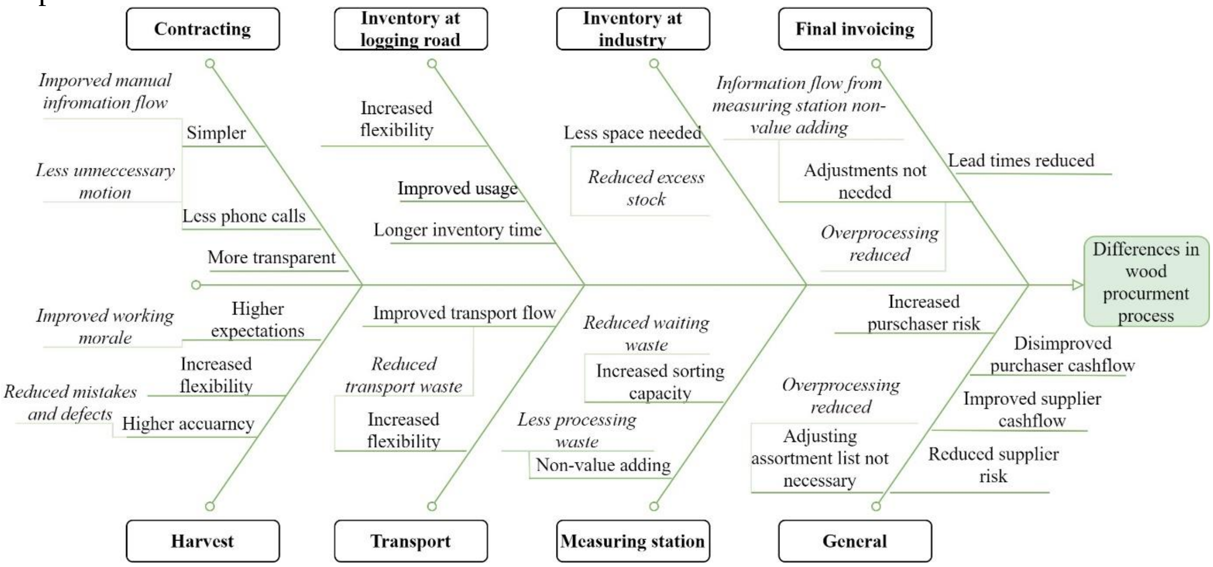

Figure 15: The diagram illustrates what activity or inventory is associated with what difference in the wood procurement process with harvest measurement compared to industry measurement.

According to Chopra (2019), firms determine their supply chain surplus by subtracting their input with the output value. Figure 15 illustrates that there is less input in the procurement process since the measuring station and adjusting the assortment-price list is not needed, less space at the industries inventories, and the transport flow and road inventory can be more flexible. By having the same output, the reduced input indicates that the supply chain surplus, and therefore also the company's profit, should increase. Furthermore, the output might also increase since there is less waste in terms of faulty lengths since the operator must check the machine more often. This might increase the surplus even further.

6.5 ABC analysis

The study's activity-based cost analysis is done by analysing data from respondents of cost in specific activities. To make the analysis comparable with the previous presented VSM, activities from the VSM are considered to be the cost pools, and activities within the ABC refer to the sub-activities that occur in each activity identified in the VSM. By doing this, a detailed illustration of how the cost pools are affected within the process is obtained.

6.5.1 Cost drivers

Contracting cost pool

Within the cost pool of contracting, the inspector must search for suppliers, negotiate with the supplier, present management suggestions, and conduct general planning. All these activities are driven by the time it takes the inspector to complete them and are affected by the contract size.

Planning cost pool

For the planning cost pool, there are mainly two tasks, field planning and transport. The main driver for the cost of field planning is the hours, which is affected by the size of the contract. For the transport task, the main cost driver is the distance the inspector drives.

Harvest cost pool

There are four tasks within the harvest cost pool: transport to site, harvest, quality control, and transport from site. The cost for transport to and from site depends on the distance to the site. The cost for the actual harvest depends on the condition of the site, size of the machine, clear-cut or thinning etc. These factors are often considered as a cost per m3 to make it tangible. The last task is quality control which is done manually by the operator with a caliper. This is driven by the time it takes the operator to conduct the quality control, which eventually is driven by the number of quality controls performed per day.

Forwarding cost pool

The cost for forwarding is also affected by transport to and from the site, which is driven by the distance to the site. The other main tasks are the transport of roundwood from the site to the road inventory, and unloading. Transport of roundwood is driven by the distance from site to the road inventory, whereas the unloading is mainly driven by the time it takes for the operator to unload. Lastly, the forwarder operator are also the one responsible for sending the harvest-teams invoice to the local office, whereas the cost for this is driven by the time it takes.

Transport to industry cost pool

After the roundwood has been unloaded at the road inventory, there is transport to industry. There are three main tasks during transport to road inventory, loading, transport to industry, and unloading. The cost for loading and unloading is driven by the time it takes, and the distance drives the actual transport cost to the industry.

Measurement at industry cost pool

Lastly, measurement at the measuring station consists of three tasks: measuring the roundwood and controlling their quality, separating loads from suppliers, and sorting the roundwood. Measurement and sorting costs are driven by the number roundwood, which is converted into m3 to make it more tangible. Separating loads from suppliers depends on the size of loads, whereas smaller loads require more separations to be made.

Figure 16 illustrates the ABC framework with the identified cost pools, activities, and cost drives from the interviews.

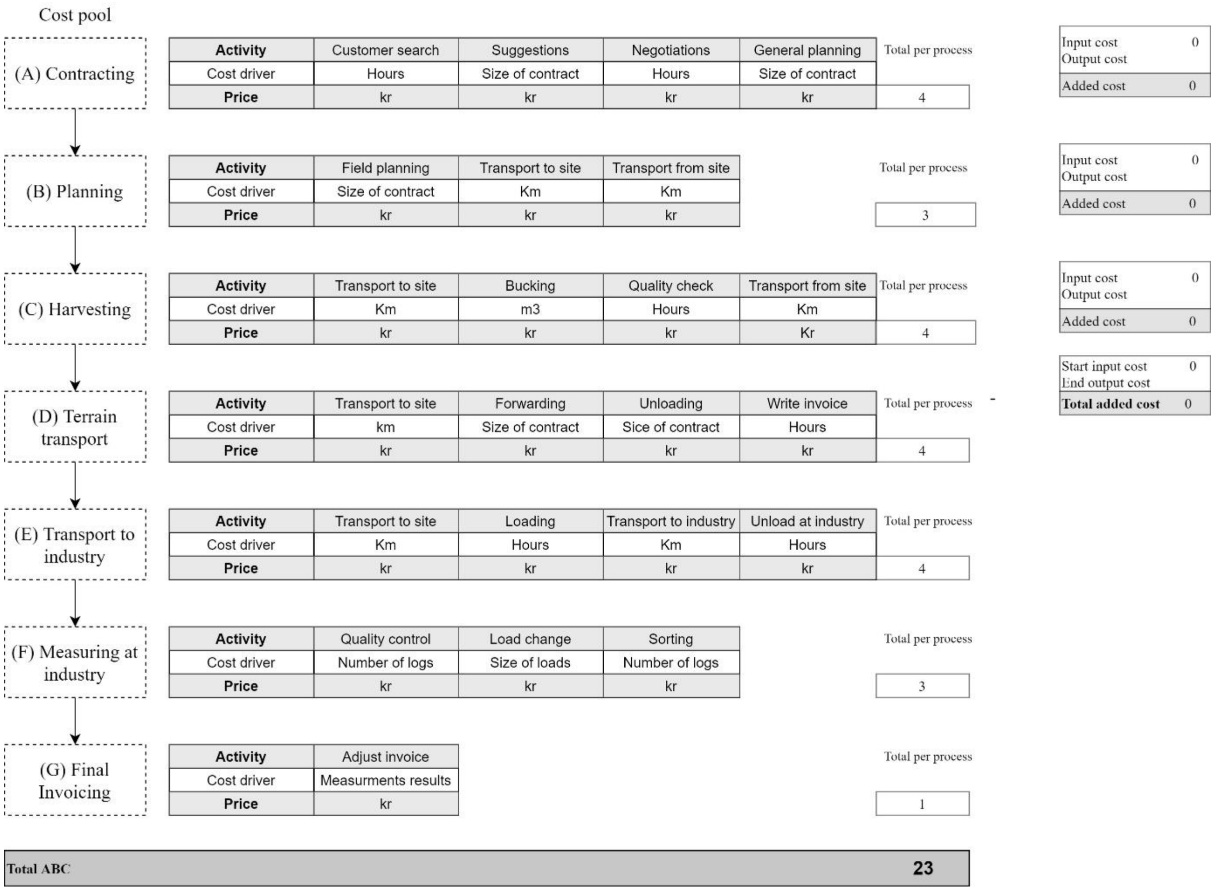

Figure 16: The ABC-analyse of the empirical material.

The total number of activity-based costs in the framework for wood procurement with industry measurement is 23. Contracting acts as accusations cost since that is the point where the market price of the material is delivered, and the supplier's terms are settled. Planning may be seen as a cost of management since it is related to the planning of the procurement. Harvest and forwarding are not acquisition costs. This is since the value of the roundwood is subtracted with the harvest and forward costs on the invoice. Therefore that should be considered as a sales cost for the supplier since he is the one paying. Transport and measurement at the industry are transport and logistics-related acquisition costs when industry measurement is used. Ownership costs occur once the roundwood has been measured and the final invoicing is completed by sending the invoice and the payment to the supplier.

6.5.2 ABC differences

In chapters 6.2 – 6.4, activities that became non-value-adding when harvest measurement is used were identified. Measurement at the industry is the only cost pool that disappears completely since the measurements are already completed during the harvest. Within the cost pool of final invoicing, adjusting the invoice becomes non-value adding and disappears since there are no volumes from the measuring station to adjust with.

Cost pools that do not become non-value adding but change are contracting, harvesting, and transporting to industry. Contracting changes slightly since less time is spent on explaining the price list. Harvesting change since there is more time spent on quality control. The operator performs two quality controls when using harvest measurement instead of one as with industry measurement. The transport flow to the industry can be arranged differently since there is no need to separate loads from different suppliers. Table 9 summarize the differences in terms of activity-based costs.

Table 9: Differences in the activity-based costs in the procurement process when harvest measurement is used compared to industry measurement

Cost pool	Activity	Difference
Contracting	Suggestions and negotiations	Less time required to explain the price list since stem-price is used
Planning	-	None
Harvesting	Quality control	More time required for quality controls
Forwarding	-	None
Transport to industry	Transport flow	Less distance might be required to and from the site due to better flow planning
Measurementat industry	All	Disappears
Final invoicing	Invoice adjustments	Disappears

The total number of activity-based costs are reduced from 23 to 19 when harvest measurement is used instead of industry measurement. Furthermore, due to the roundwood being measured during the harvest and the invoice being sent after the forwarding is complete, the following costs are changed from acquisition cost to ownership costs. Road inventory is turned into an inventory cost since the company now owns the roundwood. This indicates that the supply chain surplus increase since there are fewer steps in the process. The following chapter will quantify the difference by combining the data collected during the interviews with published data on costs.

6.5.3 Quantifying the differences

The following sub-chapter presents the differences in terms of cost per cubic meter. Published data combined with estimations from the author was used to obtain an idea of how large the difference is. The calculated total procurement costs are not validated through quantitative data or by comparing with published statistics on total procurement cost since there are no such statistics and are only included in the result to present the reader with an approximate figure. Lastly, the chapter focused on estimating the average procurement cost of regeneration fellings and thinnings.

Statistics were collected from the database of Skogsstyrelsn, and Södras annual financial report. Data on measurement costs at the measuring station was obtained by asking the previous CEO at Biometria. The following statistics were collected, including estimations made by the author.

- Södra procured 8,9 million m3ub from their members in 2020. Their total staff costs were 2205 million sek distributed over 5 million working hours, whereas 19% of the staff works within Södra Skog where the wood is procured (Södra, 2020). The author assumes that 80% of Södra Skogs total working hours are spent on procuring and distributing wood from their members. That generates an average cost of 37,7 kr/m3fub for the organization to procure wood from their members. This includes the work done, and time spent by the forest inspector, production leader, forest management leader and the district manager.

- Average regeneration felling cost, including harvest, transport, and other costs, is 106 kr/m3ub. (Skogsstyrelsen, 2021)
- Transport of the roundwood from road storage to the industry is 89 kr/m3ub. Based on the average cost of spruce-, pine timber, and spruce-, coniferous- and non-coniferous pulpwood (Skogforsk, 2020).
- The cost for measuring at the industry is about 6 kr/m3fub (Eklund, 2020)
- The average volume per hectare for a generation harvest is 367 m3sk/ha and the average volume per hectare for a thinning is 72 m3sk/ha for southern Sweden (skogsstyrelsen database, 2021). The average harvesting site is 2.3 hectares, and the average thinning is estimated to be double since there is about twice as many hectares thinned annually. An average harvest is therefore estimated to 3.45 hectares, including both thinnings and final harvests. Using a standard conversion factor of 0.83 generates an average volume per harvest of 406 m3ub. For Södra, that would equal 21880 harvests annually.
- The harvester's productivity is estimated to be 20 m3ub/h for harvest and thinning, and a typical working day is 8 hours.

Table 10: Activities and approximate cost per m3ub within each activity when industry measurement is used

Activity	Kr/m3ub	Source
Contracting, planning and final invoicing	37,7	Södra Annual Report, 2020
Harvest and Forwarding	106	Skogsstyrelsen, 2021
Transport	89	Skogforsk, 2021
Measurementat industry	6	Eklund, 2021
Total	**238,7**	

Table ten summarizes the activities and their cost per cubic meter under bark when industry measurement is used. Harvest and forwarding are considered as sales cost for the supplier, whereas the sum of the rest represents the acquisition cost for the purchaser.

Contracting, planning, and final invoicing are summarized since the cost within these are driven by the time spent on the tasks. The VSM analyses indicate that less time is spent on contracting and the final invoicing due to a simpler price list, fewer phone calls, and no need to adjust the invoice. The actual time saved per procurement is not identified, but it is assumed that the total time saved for all these activities is one hour. The total number of annual procurements by Södra is calculated by dividing the amount of wood procured by the estimated volume per harvest.

$$Estimated\ procurements\ performed\ by\ \text{Södra}$$
$$8{,}900{,}000/406\ =\ 21{,}880$$

The calculation indicates that Södra performs 21,880 procurements annually. By reducing the time spent on each procurement by 1 hour, the total time saved is equal to 21,880 hours. The hourly cost is calculated by dividing Södra Skog's staff costs by the hours worked.

$$Hourly\ staff\ costs\ for\ \text{Södra}\ Skogs\ procurements$$
$$(2{,}205\ *\ 0{,}19 * 0{,}8)/\,(5 * 0{,}19 * 0{,}8)\ =\ 418.2\ kr/hour$$

A reduction of 21,880 hours would lead to a total reduced cost of 9,2 million kr for Södra skog. Costs saved per m3fub is given by dividing the saved costs by the amount of procured wood.

$$Staff\ cost\ saved\ per\ m3ub$$
$$9{,}2\ /\ 8{,}9\ =\ 1{,}03\ kr/m3fub$$

The total cost for harvest increase since one more manual measurement is required for the quality control. One more measurement per day is estimated to take 15 minutes. Since the daily productivity will decrease, the cost per m3ub will increase. The harvester is paid per hour, and the increased cost per m3ub can be calculated by dividing the cost for eight hours of work with the reduced daily productivity. It is assumed that half of the cost for harvesting and forwarding is due to the harvester.

$$Harvester\ cost\ per\ m3ub$$
$$106/2\ =\ 53$$

$$Daily\ productivity\ with\ one\ quality\ control$$
$$20\ *\ 8\ =\ 160\ m3ub/day$$

$$Daily\ productivity\ with\ two\ quality\ controls$$
$$160 - (20\ *\ 0.25)\ =\ 155$$

$$Daily\ harvester\ cost\ with\ one\ quality\ control$$
$$53\ *\ 160\ =\ 8480\ kr/day$$

$$The\ cost\ per\ m3ub\ with\ two\ quality\ controls$$
$$8480/156.25\ =\ 54.7$$

The harvester and forwarding cost, a sales cost for the supplier, is estimated to increase from 106 to 107.7 kr/m3ub. According to the VSM and ABC analysis, the transport cost should reduce due to less waste in terms of overprocessing. Due to the difficulty in calculating transport costs, it is estimated by the author that 0.5 kr/m3fub is saved thanks to increased flexibility in how the transport flow can be arranged. Measuring at the industry is removed completely since that becomes a non-value adding activity when harvest measurement is used. Table 11 presents the estimated procurement costs with harvest measurement.

Table 11: *Estimated cost per m3 for industry measurement compared to harvest measurement*

Activity	**Kr/m3ub Industry MS**	**Kr/m3ub Harvest MS**
Contracting, planning and adminastrive work	37,7	36.7
Harvest and Forwarding	106	107.7
Transport	89	88.5
Measurementat industry	6	0
Total	**238,7**	**232,5**

The estimated quantification of the differences indicates that the supplier sales cost per m3ub with harvest measurement is 1.7 kr/m3ub higher than with industry measurement, and the acquisition cost for the purchaser is 7.5 kr/m3ub lower. The analysis does not include all the identified differences and reduced wastes covered in the previous chapter since these are complex and require more data for an estimation to be made.

6.6 Further improvements of the process

Harvest measurement seems to enable shorter lead times, fewer activities, and lower cost for wood procurement. Further technical improvements within the activities of harvest, forwarding, and transport may improve the process, but the activities are bounded to the technical difficulty of handling the physical trees in rough terrain, which makes it very difficult and expensive to improve these. The purpose of the contracting process is to find suppliers and to collect roundwood. This activity is costly and time-consuming, but there are no physical obstacles hindering hit from being fully digitalized. Virkesbörsen, described in chapter five, is meant to connect suppliers and buyers over a digital platform, partly to increase the payment to the supplier, but also to reduce the amount of time a buyer needs to spend on finding a supplier. Implementing this idea in the process, combined with recent developments in digitalized planning also mentioned in chapter five, would likely reduce most of the time and cost of the contracting and planning process. This is since most of the cost originates from the hours worked according to the ABC analysis, which according to the estimation, is 37.7 kr/m3ub.

6.7 Summary of the result

The result of this study, which focused on the first business flow in the procurement process between the supplier and procuring organization, indicates that harvest measurement can lead to:

- More flexible management of the logistics and bucking instructions
- Less waste in terms of mistakes and defects when processing trees due to more quality controls
- Measuring at the industry becomes non-value-adding.
- Reduced lead time for the supplier to receive his payment, increased lead time from harvest to roundwood arrive at industry.
- Less administrative work in terms of adjusting the invoice, adjusting assortments-price list, and answering phone calls during harvest
- Less risk is taken by the supplier and improved cash flow, higher risk for the buyer and worsened cashflow
- Sales costs for the supplier is estimated to increase by 1.7 kr/m3ub while the acquisition cost for the buyer is estimated to reduce by 7.5kr/m3ub
- Applying a digital contracting and planning process could potentially reduce the acquisition cost further

Management of logistics may be improved since the buyer owns the roundwood at the road storage, and there is no need to separate loads from different suppliers. Management of the bucking instructions may be improved since the information flow is not delayed by adjustments of the assortment lists. New bucking instructions can be sent instantly since the supplier receives his payment based on the measured volume and not the assortments taken out from the trees. More quality controls are required since the measurements from the harvester will determine the payment to the supplier, possibly leading to higher measurement accuracy and, therefore less overprocessing waste. Since the measurements are taken during the harvest, measure the roundwood at the industry becomes non-value adding. Lead time from harvest to supplier receives payment is reduced by half since the production leader does not have to wait for measurements from the measuring station. Lead times from harvest to roundwood arrive at the industry may be prolonged since there is no pressure on the organization to fulfill the lead time against the supplier. Adjusting the invoice is no longer necessary for the production leader since he already knows the costs and the harvested volume. Adjusting the assortment price list is not necessary either because a stem-price list is used instead. The inspector receives fewer phone calls during harvest since the supplier is less worried about the roundwood not arriving at the industry in time. Less risk is thereby also taken by the supplier since he is not affected by shrinkage, faulty bucking, biodegrade-, forgotten-, or stolen roundwood. Also, the supplier's cash flow is improved since he receives his payment earlier, whereas the buyer's cash flow and risk worsen. The sales costs are estimated to increase by 1.3 kr/m3ub due to higher costs during harvest, and the acquisition cost is estimated to be reduced by 7.5 kr/m3ub because of less administrative work, better logistics management and no measurement at the industry. Applying a digital contracting and planning process could potentially reduce the acquisition cost further since many of the costs originate from hours worked.

7 Discussion

This chapter will discuss the empirical findings in parallel to the problem and literature review. Furthermore, a discussion on the use and suitability of the study's methods are provided.

7.1 Empirical findings

The empirical findings in this study indicate that several activities, lead times, and costs are affected in the procurement process when harvest measurement is applied instead of industry measurement. Differences were identified with a VSM analysis, which illustrated the activities, information flows, inventories, and lead times. It made it possible to clarify differences and if any activity changed from being value-adding to non-value adding. This study focused on the first transaction in the procurement process between the supplier and the procuring organization.

The results indicate that lead time from harvest to supplier recives payment is reduced by half since the final invoicing can be completed without waiting for the roundwood to reach the measuring station. Also, the lead time from inventory at road unit the roundwood reaches the industry is believed to be prolonged. The prolonged lead time is because the transport can be arranged in a better way since there is no need to separate loads from different suppliers. These results are supported by those from Nilsson (2014), who also found that the lead time from harvest to supplier receives payment is reduced by half, whereas the lead time from inventory at the road to roundwood arrives at the industry is prolonged.

Supplier relationship is believed to be improved with harvest measurement due to the improved lead times, reduced risks, and simpler price-list. Both Nilsson (2014) and Tunstig & Magnusson (2014) argue for an improved supplier relationship with harvest measurement for the same reasons. Since this study focus on the first transaction between supplier and procuring organization, it remains unknown whether the customer relationship in the second transaction between the procuring organization and the industry is improved or worsened due to harvest measurement.

Several types of waste reductions were identified in the study whereas one of this study's findings argues for less waste of processed trees in the harvest process due to increased requirements of quality controls. Eriksson (2018) and Nilsson (2016) reported that harvest measurement does have high accuracy, as well as Biometria who reports that the accuracy level is 99% (Biometria, 2020). The reason for the high accuracy might be due to the higher standard of quality controls, as this study identified.

This study provides normative suggestions for harvest measurement, requested in Helstad's (2006) study. This study argues that the supplier's sales costs increase by 1.7 kr/m3ub while the acquisition cost for the buyer is estimated to reduce by 7.5kr/m3ub. Furthermore, this study suggests that a digitalized approach for the contracting and planning process could further reduce the cost, since a lot of the cost originates from the hours spent on these activities. Helstad (2006) also presented four different fields of improvement for the procurement process; supplier relationship, improving information flows internally and externally, developing new organisation structures, and improving bucking instructions and price lists. The empirical findings of this study suggest that harvest measurement does improve supplier relationships, improves internal information flows, and enables the use of a less complex price list.

7.2 Choice of methods

7.2.1 Identifying the process

This study used all three parameters from the framework made by Kotzab *et al.* (2010) to identify and analyze the procurement process, using Lean as the base for the SCM theories. The ABC analyses were also based on the ABC framework provided by the authors. This study was able to identify factors that optimized a process in the forest industry by applying the frameworks and comparing the same process with two different approaches. This indicates that using VSM and ABC-analyse combined with SCM theories is a good approach for identifying optimization approaches within forest industries, as Kotzab *et al.* (2010) showed in their study.

This study has mainly used the VSM to presents benefits by comparing one process technique with another. Though the study's VSM did enable an analysis of improvements, suggesting that a digitalized contracting and planning process could improve the process and reduce the costs even further. As a result, this study can support Seth & Gupta's (2007) statement that VSM is a suitable tool to deliver suggestions for improvements.

7.2.2 Collecting data through interviews

This study choose to collect qualitative data through semi-structured interviews rather than collecting qualitative data. This enabled in-depth discussion, which led to a very broad but still detailed understanding of the procurement process. Bryman & Bell (2017) and Yin (2011) argue that an interviewer must be aware of the purpose of the interview and have adherence. This was ensured by the construction of an interview guide presented in the appendix. Since several of the respondents turned out to share several different advantages and disadvantages of harvest measurement, despite having different roles in the procurement process, adherence was achieved, and the interview guide turned out to be successful.

Only six respondents participated in the study. This was because saturation was met after just a couple of interviews with the respondents from the district office, and the last three was with very specialized professionals with unique knowledge.

7.2.3 Parameters and reliability of the analysis

The VSM and ABC analysis were, for the most part, based on established and well-used techniques. However, there has been a limited application of the techniques on the forest industries (Kotzab *et al* 2010). The study aimed at having a transparent description of the analyses as well as the results to enable future studies to replicate the method. Within the study's research quality assurance, transferability a principle for quality assurance (Guba and Lincolns 1994), was also included.

The last part of the ABC analyses where the cost is quantified are partly based on the author's assumptions. This interferes with the confirmability of the study, whereas a researcher is supposed to present empirical materials with no influence of preconceptions (Guba and Lincolns 1994). Due to the transferability, the quantification is transparently described, and future research can identify flaws and strength for better quantifications of the procurement process in the future.

8 Conclusions

The conclusion of the study is presented in this chapter, addressing the aim and associated research questions. Lastly, further studies within wood procurement will be covered.

8.1 Aim, research questions and further studies

This study aimed to map two different procurement processes, one where industry measurement is applied and one with harvest measurement, focusing on activities, information flows, lead times, and cost drivers. The intent was to identify differences and how it impacts waste, the supplier relationship and total costs. Furthermore, the objective was also to explore opportunities for further improving the process by looking at the latest developments within wood procurement. This thesis was limited to the first business flow between the supplier and the procuring organization, there is also a second business flow between the procuring organization and the industry.

8.1.1 Are there differences in activities, lead times, information flows and cost drivers in wood procurement with harvest measurement compared to industry measurement?

Several activities, lead times, information flows, and cost drivers differed between wood procurement with industry and harvest measurement. The main difference is that measurements from the harvester is used as payment basis, and that there is no need to measure the roundwood at the industry when harvest measurement is applied. Loads from different suppliers do not need to be separated at the industry for measurement, hence the transportation management becomes more flexible. The changed transportation conditions may lead to longer inventory times from harvest to roundwood arrive at the industry. Lead time from harvest to supplier receives his payment seems to be reduced by half because the volume and costs can be determined once the forwarding is completed. Furthermore, since loads from different suppliers do not need to be separated, the sorting capacity at the industry may increase by 10 – 15%. The contracting process was found to be easier since a stem-price list is more straightforward to explain than an assortment list. Higher expectations are put on the harvester operator during the harvest because the measured volume will now determine the supplier's payment, which may lead to higher working morale since his work has become more critical. Also, the bucking instructions to the harvester can be sent on an instant since no assortment list needs to be adjusted. The main cost drivers for the supplier's sales cost are the harvest and forwarders cost per m3ub, which is affected by the site’s conditions and distance to the road storage. The main cost drivers for the buyer’s acquisition costs are time, contract size, and distance from road storage to the industry.

8.1.2 How does the differences impact waste, supplier relationship, and total costs within the process, and does any activity become non-value adding?

Applying harvest measurement in the procurement could potentially reduce several wastes, improve the supplier relationship, increase the supplier sales cost, and decrease the buyer's acquisition costs. The study suggests that the only activity that becomes non-value-adding when harvest measurement is applied in the procurement process is the measurement of the roundwood at the industry. This is since the roundwood has already been measured in the forest by the harvester. Second, harvest measurement based on a stem-price list enables faster response for changing demand, possibly leading to less processing waste because the harvester can process trees to match the industry’s demand instantly. Waste in terms of mistakes and defects when bucking trees might be reduced since more quality controls are made by the harvest operator. There is less unnecessary motion for the production leader to adjust the invoice, and less unnecessary motion the inspector to explain the price list and answer phone calls from the supplier during and after the harvest. Furthermore, waiting in the sorting station may be reduced when there is no need to separate loads from different suppliers. Transportation waste could possibly be reduced for the same reason.

The supplier relationship seems to be improved due to reduced lead time between harvest and payment, reduced risk, and improved cashflow. Risk for the supplier in terms of shrinkage, faulty bucking, biodegrade, forgotten, or stolen roundwood have been moved from the supplier to the buyer. Furthermore, a stem-price list may be more transparent than an assortment list since less knowledge is required to understand the pricing. According to the study's estimation, the supplier's sales cost seems to increase by 1.7 kr/m3ub. This is since harvest measurement requires more quality controls by the harvester operator, thereby increasing the harvest costs, which are the main sales costs for the supplier. On the other hand, the buyer's acquisition cost is estimated to be reduced by 7.5 kr/m3ub because of less time spent on contracting and making the final invoicing, better logistics management, and no measurement at the industry.

8.1.3 Is it possible to improve the process further when looking at the latest developments within wood procurement?

This study indicates that harvest measurement does improve the procurement process, both in terms of costs, waste and supplier relationships. However, due to difficulties in improving the physical handlings of roundwood during harvest, forwarding and transport, limited improvements may be possible within these except for improved logistics management. One of the buyer's main acquisition costs seems to be time spent on contracting, planning, and final invoicing, which is estimated to 37.7 kr/m3ub in the study. Applying a digital contracting and planning process could reduce the acquisition cost since it would lead to fewer hours worked.

8.2 Further studies

This study has found that the procurement process does change when harvest measurement is applied instead of industry measurement. Further studies are required on logistics management when using harvest measurement to determine how much this saves costs. Also, studies should focus on determining the costs saved at the industry by not requiring as much inventory space. Lastly, the value of making the whole process more responsive to changes in the market with potentially less processing waste during the harvest.

This study argues that developing a digitalized contracting and planning process could reduce the procurement process by the amounts or hours spent on these activities. Since the activities are time-consuming, and the hourly cost is high, it is tempting to further investigate on the cost impact of such developments. As this study has indicated, it is possible that the procuring cost could be extensively reduced by a more digitalized approach.

Further studies should also be conducted on the suitability of the analytical methods for the forest industry. For instance, is the VSM method applicable when looking at the entire value chain from standing tree to finished product, and is it possible to apply an ABC-analysis to determine bottlenecks in the cost structure of the forest industry's value chain? In addition, further studies on a method to better include the total sustainability perspective are also required to assess the procurement process and the entire value chain's impact on the environment, economy, and people.

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APPENDIX Interview guide

Tema	**Fråga**	**Koppling till syfte**
Allmänt	Hur länge har du jobbat på Södra? Vad är dina huvudsakliga arbetsuppgifter? (kort redogörelse)	- *Allmänt*
Processen: Aktiviteter, ledtid & kostnadsdrivare	*Kan du, i grova drag, redogöra för vilka aktiviteter det är som sker i anskaffningsprocessen från kontraktering till* ***inmätning vid industrin****?* Vilka aktiviteter är du involverad i? Vad är det som sker i vardera aktivitet? Hur lång tid brukar aktiviteterna ta? Vilken är den avgörande faktorn som påverkar kostnaden i vardera aktiviteten? Tex, hektar, tid, m3 mm.	- *Identifiera aktiviteter och deras innehåll för att kunna resonera om aktiviteterna är value or non-value adding etc.* - *Identifiera ledtider och kostnadsdrivare.*
Informations-flöden & ledtider	**Vad** för information (Input) behöver du för att genomföra vardera aktivitet? **Var** får du informationen (inputen) ifrån? Hur lång tid tar det att få informationen från tidpunkten då du efterfrågar/behöver informationen? **Varför** behövs den information? Vad för information (output) skickar du vidare till nästa befattning i processen? Och till vem? Varför skickar du just den informationen (outputen)?	- *Identifiera informationsflöden, syftet med flödena, samt ledtider i flödena.*
Skillnader i processen när skördarmätning används	*Hur påverkas anskaffningsprocessen, i grova drag, av att använda skördarmätning istället för industrimätning* ***idag****?* Kan någon aktivitet genomföras snabbare genom att använda skördarmätning istället för industrimätning? Varför? Blir någon information som du tar emot/samlar in (input) överflödig?	- *Identifiera aktiviteter, ledtider, informationsflöden och kostnadsdrivare i processen med skördarmätning.* - *Skillnader i aktiviteter, ledtider, informationsflöden och kostnadsdrivare mellan*

	Blir någon information som du skickar vidare i processen (output) överflödig? Varför? Kan kostnaden i någon aktivitet påverkas av att man använder skördarmätning? Varför? Vad finns det för problem idag med att använda skördarmätning?	*skördarmätning och industrimätning*
Förbättring-möjligheter i anskaffnings-processen	Vad ser du för generella operativa fördelar respektive nackdelar med skördarmätning gentemot industrimätning? Ser du några direkta kostnadsfördelar? Finns det något mer du skulle vilja lyfta fram rörande skördarmätning?	- *Förbättrings-möjligheter i processen*

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