AN ABSTRACT OF THE DISSERTATION OF

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Existing strategies and policies have emphasized the need for cross-sector collaboration as a means for the forest sector to be more competitive. Cross-sector collaboration initiatives of forest sector companies with neighboring industries such as energy, chemicals, plastics, textiles, and packaging are gaining increasing attention as a necessary element for a successful transition to the bioeconomy. This situation presents a significant opportunity for forest sector companies to develop new products, explore new markets, and replace human dependence on fossil-based products with renewable, bio-based materials. Despite this, limited empirical research has investigated cross-sector collaborations involving forest sector companies and the challenges that these companies face in implementing collaboration across sectors.

In this dissertation, a three-phase qualitative research design was followed to investigate the key elements involved in collaborations between forest and neighboring sector companies, as well as assess forest sector company potential to collaborate with other industries. In the first phase, a systematic literature review was conducted to identify the main drivers, benefits, and challenges of cross-sector

collaboration in the forest sector, and to improve the understanding of company-level, collaborations. Results show that little empirical work has been done regarding the link between forest sector companies and other sectors. Cost reduction, competitiveness, and environmental sustainability are considered the main drivers and benefits. Forest business culture, lack of trust, and lack of parameters to evaluate costs and savings are the key challenges to implementing these collaborations.

In the second phase, a multi-case study was implemented to document four collaboration cases involving eight companies. Turbulent environments and desire to be ahead of competitors are the main reasons these forest sector companies chose to collaborate. The documented collaborations that started with an early research and development process and established with startups are more likely to be successful. Findings shed light on the elements, mechanisms, and conditions needed to implement and manage cross-sector collaborations by forest sector companies.

In the third phase, the Progress Triangle framework was adapted and used to determine the potential of Oregon's forest sector companies to collaborate with neighboring industries. Results illustrate a high perceived need to collaborate and a moderate collaborative potential in Oregon's forest products industry. Training for employees to gain new knowledge and skills on creativity and negotiation skills, increasing their exposure to new technologies and building diverse teams may help to improve the collaborative potential in the industry. Forest sector managers can use recommendations from this dissertation to implement and manage cross-sector collaborations, and address issues, barriers, and challenges in implementing collaborations with firms from neighboring industries.

Evaluation of Cross-sector Collaborations in Transition Toward the Bioeconomy: Benefits, Challenges, and Opportunities in the Forest Sector

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I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

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CHAPTER 1. INTRODUCTION

The world's population is estimated to grow by more than a billion people over the next ten years (United Nations 2017). This increase in population is changing the world around us (Näyhä 2019). It suggests a growing production and consumption of forest-based products, as well as increasing demand in the global market for materials such as textiles, chemicals, plastics, and packaging (Toppinen et al. 2017; Bauer et al. 2018). This increased demand is also driven by many profound structural changes associated with climate change, globalization, digitalization, the high growth of the middle class in some developing nations, the needs of consumers and brand owners to replace fossil-based materials with forest-based resources, and the transition toward the bio- and circular economies (Bauer et al. 2018; Kraxner et al. 2017; Näyhä 2019). This situation presents a great opportunity for forest sector companies to develop new and greener products, explore new markets, improve competitiveness and environmental performance, and stay ahead of their competitors (Bauer et al. 2018; Bugge et al. 2016; Pelli et al. 2018; Toppinen et al. 2017).

Cross-sector collaboration has gained importance as a way for forest sector companies to increase innovation and develop new business opportunities within the bioeconomy (Bauer et al. 2018; Näyhä 2019). Companies are building bridges with firms from other industries for sharing information, resources, and knowledge, and addressing challenges to solve problems and search for solutions under the umbrella of collaboration (Bryson et al. 2015; Gray 1989; Wondolleck and Yaffee 2000; Wood and Gray 1991). Collaboration initiatives of forest sector companies across neighboring industries such as textiles, energy, chemicals, or plastics are also gaining

increasing attention in the transition to the bioeconomy (Korhonen et al. 2017; Pelli et al. 2018). An example of this is UPM-Kymmene, Elopak, and Dow, which have developed a collaboration for producing an alternative, 100% wood-based packaging solution (Biomass 2018). However, cross-sector collaborations involving forest sector companies have received little attention in the existing literature (Hansen et al. 2018; Korhonen et al. 2017).

In the forest sector literature, there are several cases of inter-firm collaboration regarding ecotourism development, forest management and harvesting (Pätäri 2010; Rosa and Beloborodko 2015), company-level competitiveness (Lehoux et al. 2014), and reduction of operational costs in logistics (Audy et al. 2012; Frisk et al. 2010). Companies have also embarked on collaborations with research institutes and universities on joint projects to facilitate exploration. However, to the best of my knowledge, no empirical research has been done on cross-sector collaborations by forest sector companies and the challenges faced by companies in implementing collaboration across sectors (Korhonen et al. 2017). The lack of awareness and resources to fully implement successful collaborations are perceived as significant constraints in the forest sector (Hämäläinen et al. 2011).

Implementing successful cross-sector collaboration in the forest sector is complex and challenging, mainly because the industry has a conservative business culture (Hämäläinen et al. 2011; Orozco et al. 2013). The challenge for managers is to understand and document how to develop successful collaborations, learn from the cases that produce positive results, and address barriers in order to minimize failure. Although the existing literature has emphasized its importance, a comprehensive

evaluation of key elements involved in company-level, cross-sector collaboration in the industry is missing. Examples of elements to assess include why do companies collaborate, what are challenges faced, and what are the benefits achieved (Audy et al. 2012; Lehoux et al. 2014; Lehoux et al. 2016; Näyhä and Pesonen 2014). Further, because few firms have the resources and capabilities for capturing the opportunities presented, there is a need to develop new products by combining two or more partners through collaboration (Global Bioeconomy Summit 2018).

Although forest sector companies may have a significant opportunity to develop new products and enhance innovativeness and competitiveness in a growing bioeconomy, they must also think about the potential changes that this way of doing business would generate (Näyhä and Pesonen 2014). The changes associated with population growth and the evolving consumer need for greener products are transforming the operating environment of forest sector companies and generating new business models (Bauer et al. 2018; Korhonen et al. 2018; Näyhä 2019). Because forest sector companies possess a traditional culture that is resistant to change and they rely on low costs to be competitive (Orozco et al. 2013), experts argue that they must be transformed to be competitive (Näyhä and Pesonen, 2014). Forest sector companies planning to capitalize on bioeconomy opportunities should scrutinize these changes in business models to avoid failures. Research on competitive advantages of cross-sector collaboration may help to understand in which areas managers and policymakers need to improve to solve the challenges and barriers faced by these companies (Hansen et al. 2018).

Hence, there is a need to better understand why and how forest and neighboring sector companies collaborate, what are the key elements involved in cross-sector collaborations between companies developing new products, and how can the understanding of the key elements involved in cross-sector collaborations between companies developing new products foster integration? Company-level is considered the most suitable scope for evaluating cross-sector collaboration between unlike sectors because little is currently known about enterprise decisions to engage in these kinds of collaborations and the conditions that motivate their choices (Alexiev et al. 2016).

This dissertation is intended to enhance the understanding of cross-sector collaborations involving forest and neighboring companies, as well as explore the potential of forest sector companies to collaborate with other industries. This dissertation makes several unique contributions to the literature. First, it enhances our understanding of company-level, cross-sector collaboration in the forest sector literature and describes the main drivers and challenges of these collaborations in the forest industry through a systematic literature review. Second, it provides a modified framework for better understanding company-level, cross-sector collaborations in the forest sector. It uses a framework proposed by Bryson et al. (2015) to shed light on the elements, mechanisms, and conditions needed to implement and manage these collaborations successfully. Third, it builds on Daniels and Walker's Progress Triangle (2001) by applying the dimensions of the framework to determine collaborative potential in Oregon's forest products industry. Finally, this dissertation also contributes to the literature by investigating the key elements involved in

collaborations of forest sector companies across sectors and assessing forest sector company potential to collaborate with other industries.

This dissertation is written in a manuscript format. It is composed of three chapters that present an overview of the qualitative research method employed, and the findings, discussion, and conclusions drawn in the following chapters. Finally, it provides the main conclusions from the research study, managerial implications, and avenues for future work.

1.1 Research objectives

The following research objectives are addressed:

1. Improve the understanding of company-level, cross-sector collaboration in the forest sector through a synthesis of existing literature and, identify the role and main drivers and challenges of cross-sector collaboration in the forest industry.
2. Identify, analyze and describe case examples of cross-sector collaborations between forest and neighboring sector companies aiming to develop new products.
3. Assess the potential of forest sector companies based in Oregon to implement cross-sector collaboration with companies from neighboring sectors and assess barriers to implementing cross-sector collaboration.

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CHAPTER 2. CROSS-SECTOR COLLABORATION IN THE FOREST PRODUCTS INDUSTRY: A REVIEW OF THE LITERATURE

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Abstract

Cross-sector collaboration has gained attention from researchers in different fields of science in recent years because it represents significant business potential for forest companies to work with sectors possessing a more positive demand outlook, including those facing increasing pressure to detach from oil derivatives. Despite this, there is a lack of research regarding company-level, cross-sector collaboration in the forest sector literature. This paper seeks to enhance the understanding of the cross-sector collaboration concept in the forest sector literature and explore alternatives for forest companies to collaborate with other industries, rather than to compete. A systematic literature review is conducted to explore the relevance of cross-sector collaboration in the forest industry. Furthermore, the main drivers, benefits, and challenges of collaboration in the forest industry are identified. Results show that the literature has emphasized the importance of cross-sector collaboration for forest companies, but little empirical work has been done regarding the link between forest companies and other industrial sectors. Cost reduction, competitiveness, and environmental sustainability are among the principal drivers and benefits. Forest business culture, lack of trust, and lack of parameters defined to evaluate costs and savings generated are key challenges to forest companies implementing cross-sector collaboration.

2.1 Introduction

Cross-sector collaboration is a management tool used by organizations to address challenges in two or more sectors that organizations cannot successfully address in one sector alone (Bryson et al. 2015). Theoretical and empirical work on collaboration has been covered by many different journals and discussed across many different fields of science in recent years. The consensus is that collaboration is difficult and that the conditions for success are not always present (Alexiev et al. 2016; Esteve 2014; Murphy et al. 2015). The perceived need to collaborate across sectors has provoked two responses. First, organizations are beginning to understand they must collaborate to solve tough business and social problems to achieve beneficial outcomes. Second, organizations realize that responding collaboratively and efficiently to interconnected problems is a major challenge (Bryson et al. 2006).

The need for creating successful cross-sector collaboration is advocated by national and international strategies in the forest sector, and many companies are realizing that working alone will not be sufficient to remain competitive (Audy et al. 2012a; Hämäläinen et al. 2011; Rametsteiner 2009). Cross-sector collaboration represents a large business potential for forest companies as they work with sectors possessing a more positive demand outlook. This may be especially true for sectors facing increasing pressure to detach from oil derivatives such as chemicals, fertilizers, textiles, construction solutions, etc. (Bugge et al. 2016; Näyhä and Pesonen 2014). Further, it can enable novel, science-based technological solutions that support sustainable development and promote competitiveness in the forest sector (Hämäläinen et al. 2011). Research and sustainable innovation efforts often involve

collaboration between actors in the forest industry (Bugge et al. 2016), but few examples exist of cross-sector collaboration in the forest sector literature.

Understanding cross-sector collaboration in the forest sector requires the ability to approach the concept from a vision that highlights the processing and conversion of forest-based resources in new sustainable and innovative products, where different sectors of the bio-resource industry can provide answers to complex problems. Enhancing understanding of cross-sector collaboration is increasingly important for a successful bioeconomy era and to provide a positive contribution to human well-being (Bugge et al. 2016). There are examples of inter-sector collaboration in the forest sector literature regarding research and development (Abrudan et al. 2009; Pätäri, 2010; Rosa and Beloborodko 2015), environmental regulation (De Loë et al. 2016; Husgafvel et al. 2016; Martin and Eklund 2011), cost allocation (Audy et al. 2012a, 2012b; Frisk et al. 2010), and firm-level competitiveness (Lehoux et al. 2014; Mattila et al. 2016; Toppinen et al. 2011).

Many forest companies have embarked on inter-institutional collaborations with research institutes and universities on joint projects to facilitate exploration (Hansen 2016). However, the lack of awareness and resources to fully implement successful cross-sector collaboration are perceived as significant constraints to implementation in the forest sector (Hämäläinen et al. 2011; Näyhä and Pesonen 2014). Forest companies do not always understand the full potential for mutual, cross-sector collaboration (Näyhä and Pesonen 2014). Further, business managers often lack knowledge and resources to engage their potential partners constructively (Lehoux et al. 2014; Näyhä and Pesonen 2014; Toppinen et al. 2011).

The challenge for researchers, practitioners, and managers in the forest sector is to understand how to develop effective cross-sector collaborations that are able to produce positive results and minimize failure or uneven results (Bryson et al. 2015). Hence, to foster the understanding of company-level, cross-sector collaboration, we begin to fill the research gap to understand how forest companies can better and more efficiently work across sectors for shared impacts, work on complex problems, consider solutions, and design and implement successful partnerships. In addition, research should exemplify the nature of the relationships, the main approaches used, and the key drivers of forest sector collaboration (Audy et al. 2012a).

Given the existing research gap on company-level, cross-sector collaboration in the forest industry, there is a need to enhance our understanding of the process and potential of cross-sector collaboration in the forest industry and explore alternatives for forest companies to collaborate with other industrial sectors instead of focusing exclusively on competing. We argue that cross-sector collaboration is an under-investigated area and that a significant business potential for forest companies exists via closer cross-collaboration with industries possessing a more positive demand outlook. Therefore, the objectives of this article are to: 1) Improve the understanding of company-level, cross-sector collaboration in the forest sector literature; and 2) Identify the main drivers and challenges of cross-sector collaboration in the forest industry.

2.2 Methods

To help to improve understanding and determine drivers, and challenges of cross-sector collaboration, we conducted a qualitative, systematic literature review.

The systematic literature review is considered a structured approach for critically reviewing and analyzing published academic research by applying replicable methods (Tranfield et al. 2003). This approach is gaining popularity among researchers because it allows replicability and aims to identify gaps that may exist within the literature (Gomes et al. 2016). Figure 2.1 provides an overview of the literature review adopted.

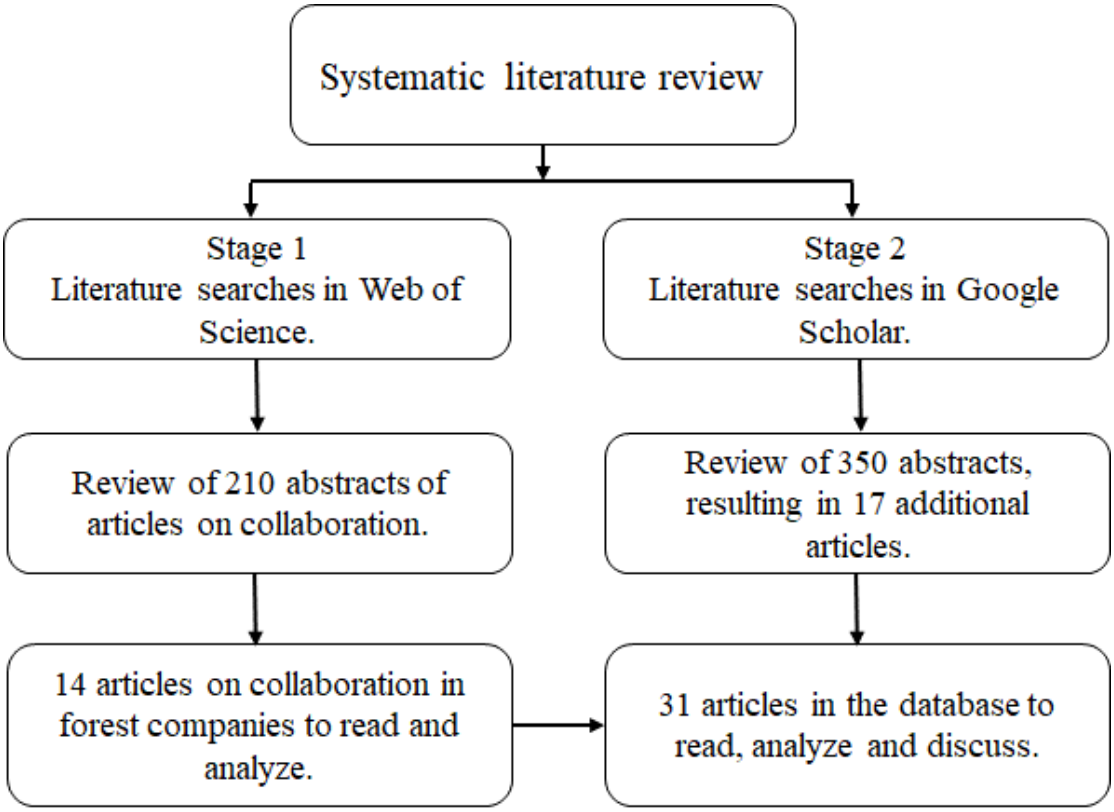

Figure 2.1. Overview of the systematic literature review.

2.2.1 Data collection

Our literature search followed a global approach to the articles on cross-sector collaboration in different areas; we then narrowed it to specific articles in the forest industry. For the sample definition, we selected a list of keywords and chose a publishing period. The list of keywords was selected based on the aim of the literature

review, to enhance the understanding of cross-sector collaboration in the forest sector literature. Collaboration in companies, cross-sector collaboration, cross-industry collaboration, cross-sector partnerships, and cooperation in companies are the keywords selected. We next sought input from eight colleague researchers which resulted in adding, collaboration in the forest industry and industrial symbiosis to our search terms. In late 2017, we searched articles published from 2006 to 2016. We chose the period 2006 to 2016 as the time frame for study because, prior to 2006, only a few articles about cross-sector collaboration had been published. Although we decided to take a global approach to evaluate the literature, we narrowed our research to literature addressing company-to-company and company-NGO collaboration. We excluded studies focused on collaboration between companies and governments (e.g., public-private collaboration).

The literature review was conducted in two stages. In the first stage, we conducted searches using the Web of Science database to identify relevant articles on cross-sector collaboration specific to the forest industry. The search resulted in a screening of 210 articles, categorized by the Web of Science in different search areas. From this initial sample, we excluded collaboration studies with no link to forest companies, as well as initiatives between forest companies and governments, such as public-private partnerships for forest protection and natural resource management. This resulted in inclusion of 14 articles.

In the second stage, Google Scholar was used as a supplement to Web Science to assure full coverage of the literature. Web of Science only covers title, abstract, and keywords, not entire articles, while Google Scholar covers the full text of articles

(Lasda 2012; Mikki 2009). The initial search resulted in 350 articles. Using the same process as described above we identified 17 additional articles, for a total of 31.

2.2.2 Data analysis

Each of the 31 papers was carefully read and the following information coded and placed in a database; article title, author(s), journal, publication date, keywords, research objective(s), research methods, industry sectors covered, results, challenges, drivers, networking strategies, case examples of collaboration, and main conclusions. Next, the database content was categorized and grouped to identify cross-sector collaboration theories, scopes, and approaches followed. Further, we identified the main drivers of company-level collaboration in the forest industry to compare them to drivers identified in other assessments in the forest sector. Collaboration drivers were placed into 12 categories. The analysis followed the principles of clustering (Scott 2017) through categorizing and grouping the drivers that share similarities such as name, forest subsectors, etc.

2.3 Results and discussion

2.3.1 What is cross-sector collaboration?

Cross-sector collaboration has been widely studied in the literature (Alexiev et al. 2016; Andrews and Entwistle 2010; Howard et al. 2016; McDonald and Young 2012). Several definitions have been proposed to illustrate it (see Bryson et al. 2006; Esteve 2014; Murphy et al. 2015). They emphasize a continuum of progressively intense inter-organizational relationships (Bryson et al. 2015). For this review, we provide a definition that includes elements that can give readers a clearer understanding of what it is and what can be achieved at the company-level in the

forest industry. Based on the multiple definitions from the article evaluated, cross-sector collaboration is defined as a management strategy used by companies to build bridges across sectors for sharing responsibilities, learning from each other, working and addressing together the challenges that companies face, as well as, accomplishing outcomes and creating value. The existing literature does not strictly differentiate terms such as collaboration, partnership, and network, each of which may imply different types of interactions among organizations (Esteve 2014). Because of the variety of labels, we use here the terms coopetition, partnership, cooperation, and industrial symbiosis networks as examples of "cross-sector collaboration".

2.3.2 Cross-sector collaboration in the forest industry

The importance of company-level, cross-sector collaboration in the forest industry is emphasized by researchers as well as national and international strategies (Bugge et al. 2016; Lehoux et al. 2014; Näyhä and Pesonen 2014). Although a considerable number of studies have promoted practices to foster and create effective collaboration across sectors, none of the 31 articles addresses implementation of cross-sector collaboration between the forest industry and other industrial sectors. Some of the studies include evidence-based practices of inter-sector collaboration in the forest industry related to environmental regulation (De Loë et al. 2016; Husgafvel et al. 2016; Martin and Eklund 2011), ecotourism development, forest management and harvesting (Abrudan et al. 2009; Pätäri 2010; Rosa and Beloborodko 2015), corporate responsibility (Kourula 2010; Strand 2009), competitive advantage (Lehoux et al. 2014; Mattila et al. 2016; Toppinen et al. 2011), and reduction of operational costs via collaborative logistics (Audy et al. 2012a, 2012b; Frisk et al. 2010).

Other conceptual studies focus on inter-firm collaborations for the transformation of forest companies to forest biorefinery businesses. Additionally, several studies address partnerships among forest companies and different industry sectors to develop industrial symbiosis networks. An industrial symbiosis network is a collaborative approach that involves local groups of industrial plants and other actors which exchange energy, water, by-products, and waste (Pakarinen et al. 2010). Although these can be considered examples of cross-sector collaboration, current work is primarily theoretical research aimed at securing value creation in forest companies (Hämäläinen et al. 2011; Näyhä and Pesonen 2014;), evaluating economic benefits and reducing environmental impacts of industry operations (Husgafvel et al. 2016; Martin and Eklund 2011; Pakarinen et al. 2010).

Cross-sector collaboration initiatives of forest companies with sectors such as energy and chemicals are gaining increasing attention. For example, value creation through collaboration between the energy and forest sectors is becoming increasingly important because bioenergy businesses need access to forest resources (Näyhä and Pesonen 2014). It is suggested that the increasing global interest in renewable energy offers profitable opportunities for forest companies to create new business models by producing bioenergy and biofuels in collaboration with the energy industry (Pätäri 2010). Hence, to secure value creation and gain sustainable competitive advantage, companies should attain skills and know-how to facilitate successful collaboration (Näyhä and Pesonen 2014).

Similarly, forest companies are willing to collaborate with research institutes and companies outside the forest sector to diversify their business, reduce operational

costs, create value and competitive advantage and reduce environmental impacts (Hämäläinen et al. 2011; Mattila et al. 2016; Näyhä and Pesonen 2014). However, company resistance to change often means negative attitudes towards collaboration (Hämäläinen et al. 2011). Although inter-sector collaboration has produced beneficial partnerships among sawmills, company managers do not see this collaboration as strategic (Toppinen et al. 2011). Perceived lack of trustworthy forest stakeholders and neighboring industries affects the potential for cross-sector collaboration. Although most forest stakeholders understand its value and importance for the forest industry (Zander et al. 2016), a winning collaboration strategy is not obvious because each stakeholder has a unique perspective (Janssen et al. 2008). These aspects linked to the individualistic orientation of forest companies, built on competition, and the traditional business culture resistant to change, limit development of cross-sector collaboration-based business initiatives in the forest industry.

Even though forest companies have distinct roles and perspectives, forest businesses of the future must compete and respond to global market demand (Wolfslehner et al. 2016). The importance of cross-sector collaboration as an innovative way to solve problems presents a significant opportunity for forest companies through developing new products and exploring new markets. An example can be found in the partnerships among local communities and forest businesses to develop sustainable forest management plans (Kourula 2010; Wyatt et al. 2013). These collaborative programs could generate sustainable economies by providing provisions for those involved to make money from harvesting, forestry protection, and recreational activities for the public.

2.3.3 Design and implementation of cross-sector collaboration processes

Several initiatives have been implemented in the forest sector to increase innovativeness of forest companies through research in collaboration along the value chain (Hansen 2010). But what motivates forest companies to collaborate and work together with rivals instead of competing? How can forest companies design, build, and manage cross-sector collaboration? Increasing competitiveness against rival companies is the motivation for collaborations among forest companies (Audy et al. 2012a). Further, to determine how to design, implement and manage collaboration, as well as, to share benefits is crucial to ensure the long-term stability of the partnership (Lehoux et al. 2014). Figure 2.2 provides a visual representation of the process of implementing cross-sector collaboration. The figure illustrates three main steps of the process: starting conditions, building and managing, and measuring performance and benefits. Each of these principal steps is disaggregated into additional activities that facilitate collaboration among partners.

Collaboration starting conditions set the scope regarding the location and project to focus on and the goals that are expected to be reached. The building and managing step set the basic rules under which the relationship takes place. It includes the identification of the form of collaboration to follow, leadership roles and characteristics, formal agreements, and benefits to be shared before implementing and monitoring. Lastly, when small intangible wins are reached (e.g., trust-building and commitment) and tangible outcomes from the collaboration are achieved, measuring performance and benefits processes are set (Ansell and Gash 2008).

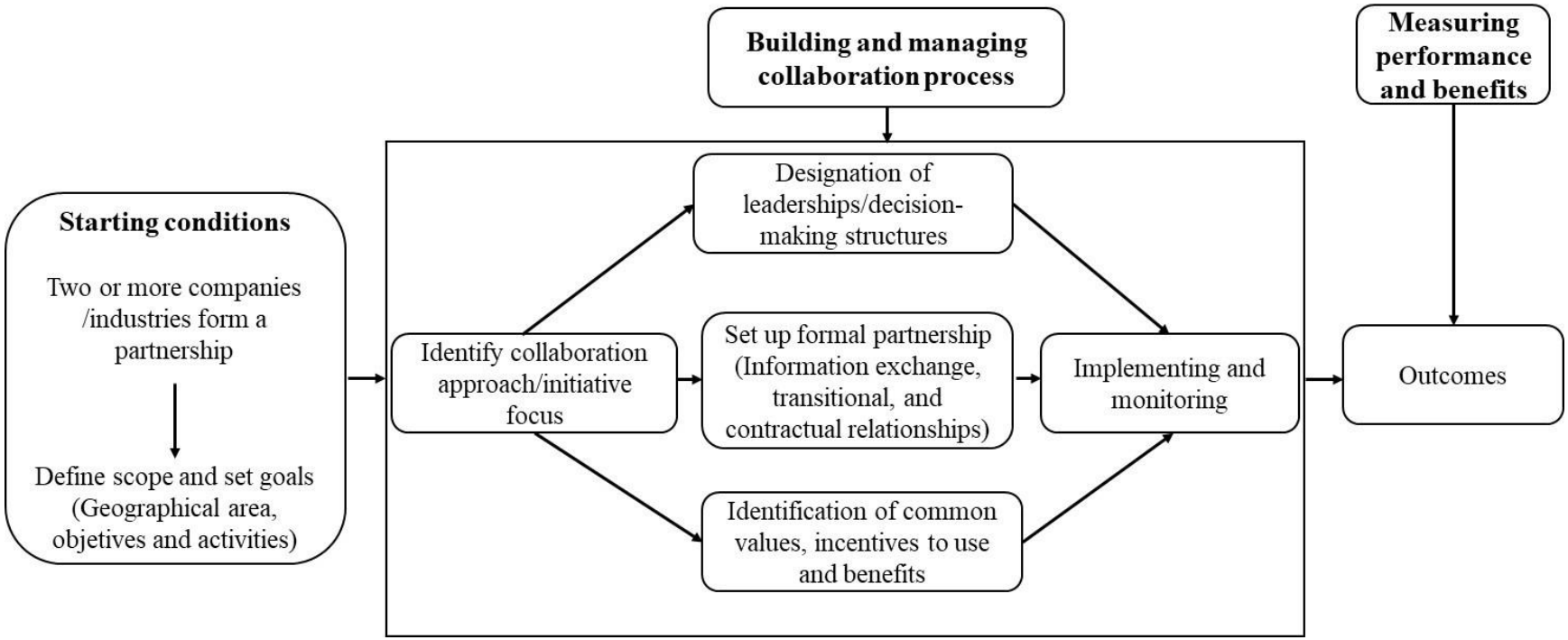

Figure 2.2. Implementation process for cross-sector collaboration (modified from Ansell and Gash 2008).

2.3.4 Drivers of cross-sector collaboration in the forest industry

Table 2.1 describes 12 groups of collaboration drivers classified by similarities. We identify 109 drivers of company-level, cross-sector collaboration in the forest industry from the literature. Table 2.2 includes a detailed description of the individual drivers identified. Most studies report external collaborative drivers, but significant internal drivers are also identified. Table 2.1 shows that environmental concerns of the companies and environmental performance are the most mentioned drivers. Competitiveness, cost-based strategy, and sustainability drivers follow in order of importance. The category corresponding to savings, a driver for cost reduction in collaboration (Frisk et al. 2010), and corporate responsibility, represented the least mentioned drivers.

Table 2.1. Categorization of cross-sector collaboration drivers in the forest industry from the systematic literature review (n = 109 drivers).

Driver	Frequency
Environmental concerns and performance	25
Competitiveness	15
Cost-based strategy	14
Sustainability	12
Forest raw material, management and harvesting	10
New business models	9
Value creation	8
Innovativeness	4
Networking	4
Market development	3
Savings	3
Corporate responsibility	2

Note: Most studies have more than one driver.

Table 2.2. Theoretical framework for cross-sector collaboration in the forest industry

Theory	Articles	Scope	Drivers	Benefits	Challenges
Collaborative planning	Audy et al. 2007, 2012a, 2012b Carlsson and Ronnqvist 2007 D'Amours et al. 2008 Frisk et al. 2010 Lehoux et al. 2014	Analyzes how forest companies establish collaboration with other business in their supply chain to optimize their processes, reduce costs, and remain competitive.	Transportation issues Reduce operational cost Competitive pressure Logistics optimization Environmental concerns	Savings Faster delivery time Cost reduction Better planning decisions Overcome limitation Cost sharing associated Optimizing operations	Lack of trust among partners Partners selection Definition of cost and benefits Develop win-win relationships Changes in business process Leadership role
Collaboration portfolio	Chambost et al. 2009 Hämäläinen et al. 2011 Janssen et al. 2008 Näyhä and Pesonen 2014	Outlines and explore partnership initiatives for forest biorefineries business and product portfolio extension for forest and energy companies.	Business diversification New added-value products Environmental sustainability New business opportunities	Value creation Lower production costs Supply chain optimization New business opportunities Environmental sustainability	Partner selection Individualistic orientation Forest sector tradition Short-term cash flow objectives Leadership role
Collaborative network	Abrudan et al. 2009 Kourula 2010 Mattila et al. 2016 Mayfield et al. 2007 Patari 2010 Rusco 2011 Toppinen et al. 2011	Identifies the principal industry- and company-level factors likely to influence the different businesses associated with the forest sector to increase its value-creation potential.	Innovativeness Competitiveness Value creation Waste reduction Forest and environmental sustainability Corporate responsibility	Largest wood market Increased eco-tourism Long-term relationship Deeper customer involvement Efficiency in marketing Best used of limited resources Competitive advantage	Collaboration is challenging Collaboration is not a strategy advantage Forest companies are disconnected from other industrial sectors.
Collaborative partnership	Fortier et al. 2013 Strand 2009 Wyatt et al. 2013 Wyatt 2008	Explores how communities and companies develop long-term, collaborative partnerships on issues such as corporate responsibility, sustainable forestry, etc.	Corporate social responsibility Sustainable forest management	Sustainable forest management and timber harvesting Access to employment Reducing conflicts Trusting relationship	Forestland management Environmental and societal challenges
Industrial symbiosis networks	Husgafvel et al. 2016 Karlsson and Wolf 2008 Martin and Eklund 2011 Pakarinen et al. 2010 Rosa and Beloborodko 2015 Sokka et al. 2011	Outlines research initiatives and new products development from forest-based waste and evaluates the global implications of the industrial symbiosis for the forest industry.	Environmental performance Sustainable development Increase profitability System cost reduction Increase profitability	Savings Waste reduction Improved environmental performance Avoided greenhouse gas emissions New products development Manufacturing optimization Competitive advantages	Difficult to determine savings Creation of innovative technology Keep low operating costs
Network governance	De Loe et al., 2016 Zander et al. 2016	Explores how the drivers of network governance might enhance collaboration in the wood industry to facilitate efficient utilization of renewable resources.	Waste reduction Environmental sustainability	Resource exchange by companies Operations improved Cost-effective solutions Less environmental load Eco-innovative solutions	Lack of trust among partners Leadership role
Social network analysis	Velenturf 2016	Highlights industrial symbiosis for collaboration among industries to use bio-based products and generate power and fuel from secondary biomass resources.	Resource efficiency Increase business growth	Reutilization of waste resources Low-carbon generation Efficient use of resources	Keep collaboration in time

Most cross-sector collaboration drivers provided in this classification are similar to the drivers identified in other forest sector assessments on topics such as sustainable forest management, green buildings, and mass timber construction development (Ahn et al. 2013; Jones et al. 2016; Jonsson 2013). However, information regarding the change that these drivers could achieve in facilitating implementation of company-level, cross-sector collaboration processes in the forest industry is scarce.

2.3.5 Collaboration benefits

Twelve of the 31 papers in this study are focused on the supply chain of the forest industry (Audy et al. 2012a; D'Amours et al. 2008; De Loë et al. 2016). Benefits of collaboration are classified into two categories: quantitative (e.g., cost reduction, delivery time reduction, etc.) and qualitative (e.g., learning new logistics skills, overcoming limitations, etc.) (Audy et al. 2012a). The evaluation of quantitative benefits of collaboration is conducted using different operational research methods in logistics. The optimization of operations, cost reductions, and savings are the most common quantitative benefits in the context of transporting logs to mills (D'Amours et al. 2008). The minimization objectives such as savings in transportation and cost reduction are reported to be the most significant benefits gained from the management of logistics collaboration (Audy et al. 2012b). Savings and profit-sharing benefits through a cost allocation method in collaborative forest transportation (Frisk et al. 2010) and, cost-sharing in product development, transportation, and warehousing are described among the leading quantitative benefits in collaborative transportation (Lehoux et al. 2014).

Qualitative benefits are difficult to evaluate because they are intangibles. Benefits include improving the experience to overcome limitations and learning new logistics skills (Audy et al. 2012b). Additionally, developing operational and institutional capacity and achieving conflict reduction are emphasized (Fortier et al. 2013). Based on Husgafvel et al. (2016), potential new business opportunities, competitive advantage, and improved environmental performance are considered qualitative benefits of collaboration when compared to the use of primary raw materials. Further, long-term relationships, response to changes, reduced risks and uncertainty, and better planning decisions are also described as qualitative benefits of collaboration (Lehoux et al. 2014).

Table 2.2 provides a detailed description of the collaboration benefits discussed in the 31 articles. Forest companies are willing to collaborate if they can obtain greater benefits from the partnership than those obtained individually. Hence, it is essential to identify the value and benefits and how they will be shared.

2.3.6 Challenges, risk, and barriers

Company-level, cross-sector collaboration is an authentic challenge. The individualistic orientation of forest businesses and lack of trust in stakeholders affects the development of new business models, innovations, value creation, and competitiveness (Hämäläinen et al. 2011). Forest industry is a traditional business that builds on competition, where collaboration inside the sector, as well as with other industrial sectors, is neglected. The resistance to change and varying visions of management are the most significant challenges to collaboration in forest industry (Näyhä and Pesonen 2014). Some managers do not consider collaboration a business

strategy or competitive advantage for their company (Toppinen et al. 2011). Some examples of collaboration show how companies can legitimize their operations with stakeholders, increase reputation and limit risk by building knowledge and long-term relationships (De Loë et al. 2016).

Collaboration can generate risks for companies. These risks include aspects associated with lack of confidentiality in the information shared, lack of control of the partner relationship, and lack of planning (the absence of a plan to predict where a company wants to be in the future, listing specific, and measurable goals and results) etc. (Lehoux et al. 2014). In the transition to a bioeconomy, changes in the direction of forest companies toward biorefinery businesses will present large challenges for leadership and management in the forest industry. Conservative organizational culture, sharing profits among partners and the lack of trustworthiness are some of the critical challenges (Näyhä and Pesonen 2014). Partner selection, short-term cash flow objectives, and the quality of partnership are considered usual challenges in collaboration. Further, economic, technological, financial, cultural, and operational aspects are described as key risks (Chambost et al. 2009). Another area of challenge for collaboration is supply chain planning. The integration of different business units in the wood products supply chain is still viewed to be a major challenge for industry (D'Amours et al. 2008).

Collaboration remains a complex subject in the wood products supply chain with many issues still to be solved. Therefore, those businesses that are willing to collaborate and share resources, risks, and benefits, may gain competitiveness, enhance capacity and reduce possible negative impacts. Defining top challenges to

overcome to achieve successful cross-sector collaboration will require extra work, exceptional discipline, and improved coordination among researchers and practitioners in the forest sector. Although working through it will take time, the efforts may be worth it in the long run for forest companies.

2.3.7 Examples of cross-sector collaboration in the forest industry.

The collaborative efforts of companies in the forest sector start in the first half of the twentieth century via promotion of research and development (R&D) collaborations for environmental adaptation in the pulp and paper industry (Söderholm and Bergquist 2012). Since then, most forest sector collaboration has focused on collaboration among companies within the forest industry rather than across sectors. This section discusses cases of inter-sector collaboration implemented across five different forest industry sub-sectors.

I. Forest management and environmental legislation

Environmental legislation has gained an expanded role in the management of forest resources in recent decades, motivating increased collaboration among forest companies, communities, governments and other stakeholders (Fortier et al. 2013). These collaborations adopt various forms and lead to changes in public policy and economic demands facing forest companies. In Canada, forest companies and indigenous peoples have developed several arrangements to foster collaboration and increase the role of aboriginals in managing and harvesting forestlands. These forms of collaboration use different approaches for determining benefits to forestland that can provide practitioners with a tool to achieve effective collaboration (Wyatt et al. 2013). Companies are investing in several programs designed to collaborate and

increase participation of aboriginal peoples in forest management and harvesting. These programs seek to incorporate indigenous peoples' values and knowledge in forest management activities (Wyatt 2008).

Collaboration have also resulted in essential developments and impacts in the Romanian forest sector in the last twenty years. Forest-based interaction with environmental protection, wood processing, and tourism industries have positively impacted the evolution of the forest industry. Further, collaboration and cooperation among environmental authorities and forest and tourism sectors have significantly increased the development of ecotourism in Romania. Now, ecotourism is a new priority for both forest and tourism businesses (Abrudan et al. 2009).

II. Corporate social responsibility

Cross-sector collaboration among governments, civil society, and companies has become a necessary element of public forest management and has been a focus of corporate social responsibility researchers. Along with governments and companies, key stakeholders for collaboration in the global economy are NGOs. The efforts in managing corporate social responsibility in the forest industry have been fostered by the collaboration between multinational enterprises and NGOs (Toppinen and Korhonen-Kurki 2013). For example, practices and roles in cooperative advantage (quality of being recognized as a trustworthy and favorable partner to do business) are explored in four multinational corporations: IKEA, Nokia, Novo Nordisk, and Statoil Hydro. Results show that these companies have developed a cooperative advantage in their ability to form successful long-term partnerships in their respective supply

chains, as well as addressing issues of corporate responsibility such as sustainable forest management (Strand 2009).

Another way that companies are managing corporate social responsibility is through ongoing development of collaborative stakeholder relationships. Collaborations with stakeholders are powerful. Strategies for implementing corporate social responsibility and achieving company economic and social objectives often rely on collaboration (De Loë et al. 2016). Some natural resource enterprises such as forest companies are motivated to participate in collaborative processes for addressing water governance issues. These processes offer benefits to companies for appreciating the opportunities that collaboration presents about relationship building and risk management (De Loë et al. 2016). However, companies are not always open to a collaborative group influencing their operations. In corporate social responsibility, forest companies are actively searching for collaboration and signing cooperation agreements with stakeholders (Kourula 2010). This collaboration strategy is beneficial since it provides cooperation benefits and the development of long-term relationships.

III. Logistics and transportation

Transportation is a critical part of the supply chain for most forest companies. Different collaborative logistics approaches have been used to solve transportation issues for forest companies operating in the same region. In the transportation of wood products in Sweden, a centralized approach for collaborative planning to support coordination in forest companies is proposed by Audy et al. (2007). The approach uses a decision support system that follows the wood fiber flow chain as the

central planner for collaborative transportation. Four business models driven by the leading company are tested and savings by the companies in the coalition are illustrated. Similarly, a cost allocation method is introduced to test how the costs can be distributed and profits shared among participants (Frisk et al. 2010).

The optimization of logistics activities motivates enterprises to establish collaboration with many other business entities. The utility of logistics collaboration to efficiently build and manage inter-sector collaboration is highlighted by Audy et al. (2012a). Coordination of wood flow among companies can lead to significant transportation cost reduction. In logistics collaboration, companies cooperate to reduce operational costs and respond efficiently to market demand. The benefits of implementing collaboration mechanisms in the supply chain and using incentives to share these benefits are tested between a pulp and paper company and its wholesaler. Implementation of these collaborative approaches may contribute to improving the performance of the forest business (Lehoux et al. 2014).

Logistics collaboration has been explored for supply chain planning in several forest subsectors such as harvesting and transportation scheduling, transporting logs to mills, and partnering with paper mills and customers. Collaboration in the forest industry is linked to company supply chains, where some studies show the value of collaboration to solve challenges and reduce costs (Audy et al. 2007; Frisk et al. 2010; Lehoux et al. 2014). The development of new collaborative mechanisms to integrate the forest industry supply chain to other industrial sectors may help extend these benefits. Researchers and practitioners should work together to develop cross-sector collaboration initiatives to support such integration.

IV. Wood products manufacturing

In the context of wood products manufacturing, some beneficial collaborations among sawmills and wood construction companies have been developing. In an analysis focused on long-term cooperation in the Finnish sawmilling and wood processing industry, value creation and performance improvement through coopetition are emphasized as the main motives for companies to cooperate with competitors. When companies emphasize value creation in the context of coopetition, their goal is to create a bigger business pie while competing to divide it up (Rusko 2011). Inter-firm collaboration has also been explored as a path of creating competitive advantages and a strategic resource for Finnish sawmilling industry against the growing global competition (Toppinen et al. 2011).

Regarding the evolution of strategic business networks in the wood products industry, an example of network-based business models is reported in two wood companies in Finland. The studied Finnish wood companies have a positive attitude toward developing networking business models (Mattila et al. 2016). The main drivers of network modes of governance are assessed in the German wood industry by combining exploratory examples using network relationships. Network-based collaboration is implied to be beneficial for the efficient utilization of byproducts and the reuse of renewable raw materials. Further, asset specificity - the extent to which a company is tied in a business relationship where its investment will be likely to have equal or higher returns (Williamson 1981)-, supply uncertainty, interdependence of core activities, and relational rents are found to be major factors affecting the formation of network-based collaboration in the wood industry (Zander et al. 2016).

This collaboration approach is highly beneficial for companies in the wood industry where efficient utilization of resources across company boundaries is crucial.

V. Forest bioeconomy

The bioeconomy has emerged as an innovative solution for reviving the forest industry (Wolfslehner et al. 2016). The forest industry may play a significant role in a bioeconomy because it relies on renewable raw materials, bioenergy and other services. However, there is an increasing need for collaboration among business enterprises, practitioners, and managers that can help to reach consensus on the direction the forest-based bioeconomy should take (Wolfslehner et al. 2016; Bugge et al. 2016). Industrial symbiosis networks are gaining significant importance in the forest-based bioeconomy (Rosa and Beloborodko 2015). Industrial symbiosis create a mutually beneficial relationship based on industries that achieve productive use of waste and by-products and promotes sustainable development by providing economic benefits while minimizing environmental degradation caused by the participating industries (Chopra and Khanna 2014).

The benefits and relevance of industrial symbiosis networks have been recognized. In a study on contributions of industrial symbiosis to sustainable energy use in Finland, Sokka et al. (2011) quantify the greenhouse gas emissions from fossil fuel and energy consumption.. Results show that industrial symbiosis can provide large environmental benefits such as lower waste and emissions in comparison with stand-alone systems. Similarly, the total production costs of an integrated industrial symbiosis system of a chemical pulp mill, a sawmill and a biofuel upgrading plant are compared to a system with similar stand-alone facilities. The integrated symbiosis

system has higher economic benefits and lower environmental impact than the independent system (Karlsson and Wolf 2008). In life cycle assessment of a granulated forest fertilizer from the fly ash of bioenergy production and sludge of water treatment in the forest industry, it is shown that the fertilizer can produce less environmental burden than commercial fertilizers (Husgafvel et al. 2016).

Based on a study in the UK, Velenturf (2016) explores how companies implement the innovative use of wastes and develop collaborations with secondary biomass resource suppliers. He suggests that companies must diversify their resource partners in the innovation process. Enterprises prefer to develop resource partnerships with familiar companies, or in sectors that they already know. Assessment of examples of industrial symbiosis is necessary to develop and promote new collaboration initiatives. Quality should be considered before planning the collaboration to achieve an optimal and sustainable industrial symbiosis network (Rosa and Beloborodko 2015).

Forest biorefineries are another principal element in the implementation of bioeconomy strategies at regional and national levels. Wood-based biofuel and biomass energy products are considered a serious opportunity for diversifying business in the forest industry (Hämäläinen et al. 2011). Nevertheless, the lack of collaboration among forest and bioenergy companies is considered a barrier to forest biorefinery diffusion. The introduction of new insight and know-how from other industrial sectors, research centers, and technology providers through cross-sector collaboration could improve the success of forest biorefinery businesses (Hämäläinen et al. 2011).

The current state-of-knowledge, opportunities, barriers, and actions for developing a more significant bioenergy and bio-based products industry are evaluated in the Southern US. Collaboration, education, and market creation emerge as the most critical themes to the successful development of the biomass industry. It is suggested that cross-sector collaboration among forest industry, energy sector, academia, and rural communities to support research, policy issues, and educational programs will enhance the efficiency and promote the use of forest biomass for bioenergy (Mayfield et al. 2007). Forest resources are explored for enhancing the understanding of the biorefining business in Scandinavia and North America. The best way to achieve success in the forest biorefinery business is through collaboration and partnerships with other industrial sectors because the right set of skills and knowledge can be combined (Näyhä and Pesonen 2014).

Similarly, industry- and company-level factors likely to influence the bioenergy sector, its value creation, and future role of companies in both the forest and energy industries have been assessed. Collaboration is considered more profitable than competition for the forest and energy industries. Hence, complementary resources (resources shared between small and large companies that are suited to facilitating collaborative innovation processes) held by forest and energy companies make collaboration in the forest bioenergy business favorable (Pätäri 2010). However, some forest company attitudes reflect resistance to change. These companies are willing to promote forest biorefinery diffusion, but they have a negative attitude towards issues concerning collaboration. They are not willing to cooperate across industries to promote biorefinery diffusion.

The transition toward a bioeconomy implies opportunities for the forest sector; however, it also involves challenges to a degree that the edges and scope of the forest sector might change drastically (Kleinschmit et al., 2014). For example, forest company collaborations with industrial sectors such as energy might be realized in a form where forest companies take part as biomass providers rather than partners in the generation of new bioproducts (Näyhä and Pesonen 2014). Company-level, cross-sector collaboration is an area that still deserves more research to reach consensus among researchers and practitioners on the direction that it should take in a forest-based bioeconomy (Kleinschmit et al., 2014).

2.4 Lessons learned and future research

In this section, we describe and discuss lessons learned from the literature. Our discussion follows the framework in Table 2.2. We also provide recommendations to ensure that lessons are learned, and mistakes are not repeated in the future. Finally, we suggest some ideas to guide future research.

Based on the lessons learned in this review, we conclude that the implementation of cross-sector collaboration is difficult for forest companies for a variety of reasons. It requires that each step of the process is carefully developed. Companies must deal with issues such as finding partners interested in establishing long-term collaborations for developing new products rather than business-to-business associations to selling products or developing new projects (Lehoux et al. 2014). An example of this is the case of architectural firm, and concrete and wood manufacturers companies to build wood-hybrid construction systems for high-rise buildings (Dickof et al. 2014), where the collaboration is related to day-to-day

operations. Identifying the types of benefits expected, setting goals of the relationship, and ensuring an attractive collaboration for both parties can help companies to prioritize their partners and build stronger relationships. A robust cross-sector collaboration can easily lead to continued collaboration, new product development and value creation (Murphy et al. 2015). We suggest that future research could develop the criteria to evaluate and choose collaboration partners, as well as the parameters to consider for building collaborations.

Cross-sector collaboration implementation also requires radical changes in business process and sharing of critical resources (e.g., information and knowledge) and sharing of leadership. Changes can mean a shift in company focus and leadership role, or sharing of sensitive information such as technical details and know-how. (Zander et al. 2016). Traditional industry culture, leadership and management roles, lack of trust between partners, and lack of parameters to evaluate potential costs (e.g., transactions costs, information acquisitions, etc.) and savings generated by this way of doing business are challenging barriers to overcome in developing collaboration (Lehoux et al. 2014; Näyhä and Pesonen 2014).

Forest industry culture, considered traditional and change-resistant, is also a significant limitation. Industry culture influences the entire business environment in forest companies. It has a major effect on the management style, level of collaboration, and a substantial impact on the ability to innovate (Orozco et al. 2013). We believe that a change in the forest industry culture will foster collaboration with neighboring sectors. For example, integrating more diverse teams, hiring young managers, embracing knowledge from outsiders, investing in overcoming lack of trust

between partners, and implementing open innovation would help in a cultural change when establishing new partnerships. Further, we suggest that future research could be developed for sharing knowledge and performing collaborative innovation in wood construction. For instance, research could identify and describe case examples of cross-sector collaboration between wood and concrete companies, as well as exploring initiatives for creating and developing wood-concrete hybrid systems to be used in housing and tall wood building projects.

Implementing cross-sector collaboration represents a significant challenge for leadership and management (Näyhä and Pesonen 2014). For example, employees and managers feel that the potential changes generated for this are a threat to their jobs and their leadership positions. They think that their jobs will be replaced, or they will lose control of their operations (Lehoux et al. 2014). Further, employees and managers do not know what information can be shared to support the collaboration (Audy et al. 2012a). Forest companies must involve and inform key stakeholders in the legal framework of the new partnership to avoid misunderstandings, as well as, provide training programs emphasizing the knowledge needed for managers and employees to implementing collaboration initiatives. These companies will require leaders who can provide long-term vision, networking strategies, and innovativeness attitudes to identify new business opportunities across sectors leading to transition to the bioeconomy. Applying social network analysis theories is another attractive avenue for future research that can enhance understanding of the relationships and processes involved in implementing collaboration in the forest industry.

Lastly, our evidence shows that there is a lack of parameters to assess the potential cost and savings associated with implementing collaborations. Some collaborative models do not consider all possible costs involved in the partnerships. Further, most companies are unable to identify where savings come from in collaboration (Frisk et al. 2010; Hämäläinen et al. 2011; Sokka et al. 2011). Identifying the right partner, financial costs, potential risks, and indirect benefits before evaluating and selecting the collaboration mechanism will help companies to be better prepared. The transition cost approach, a theory accounting for inclusion of all costs of producing a product or service (Williamson 1981), can be helpful in this process. We suggest that future research can apply a transaction cost approach to develop parameters for measuring costs and savings generated from collaborations. Developing these types of parameters in the future might help forest companies to change their way of doing business and to implement cross-sector collaboration.

2.5 Conclusions

Cross-sector collaboration remains a major challenge for forest companies. Forest companies can be described as possessing a traditional business culture that is resistant to change. In addition, they tend to have an individualistic orientation built on competition where collaboration is neglected. Although the literature outlines many theoretical benefits of collaboration, forest companies generally lack the motivation to change their ways of doing business. For these companies, it is challenging to share knowledge and resources or collaborate with outside partners, maybe especially with those outside the forest sector. Forest companies prefer to develop partnerships with enterprises with which they are familiar. Lack of trust

among partners is a key challenge for future implementation of company-level, cross-sector collaboration in the forest industry. The challenges faced by forest companies call for interdisciplinary partnership solutions.

Our review shows that the literature on company-level, cross-sector collaboration specific to forest companies is scarce. However, research and theoretical initiatives on cross-sector collaboration of forest companies across neighboring sectors such as energy and chemicals are gaining increasing attention in the literature. Most studies in our review focus on examples of inter-sector collaboration that address topics such as ecotourism development, forest management and harvesting, and creation of competitive advantage and achievement of savings in logistic and transportation planning. Logistics collaboration in the forestry supply chain has received the most attention. The benefits achieved by companies in their forestry supply chains, and because of the value of collaboration to solve challenges and reduce costs, have been extended into other forest products supply chains. There remain significant gaps in the literature that deserve future attention.

Cross-sector collaboration is critical, yet the academy has done little to explore the context within which this strategy can be successful. Our findings suggest several pathways for future empirical studies. Studies evaluating willingness to implement cross-sector collaborations by forest companies, evaluating perceived hurdles to collaboration, and identifying potential sectors to choose for partnerships are key areas for future research. Researchers and practitioners should work together to develop new models to support partnerships among forest companies and industrial sectors possessing more positive demand outlooks. Cross-sector collaboration in the

forest industry suggests the opportunity for diverse types and forms of innovation to develop new products and enhance profitability. Documentation of successful examples of cross-sector collaboration will capture the attention of managers and facilitate future collaboration efforts.

Our findings illustrate cross-sector collaboration in the forest industry. However, they also provide valuable information to help public managers, practitioners, and leaders to implement cross-sector collaboration to address social needs and public issues. Although challenges for implementing cross-sector collaboration will differ, leadership roles will be key elements for its success. Leaders' visions, strategies, and attitudes may be valuable to reduce challenges of aligning initial conditions, setting up decision-making structures and processes, and identifying outcomes. More research is needed regarding the role that leadership can play in collaboration. Future research may also focus on assessing the role of leadership at distinct stages of a collaboration process, and how to achieve successful leadership in shared structures in cross-sector collaboration.

2.6 Limitations

The existing body of research on cross-sector collaboration, as reflected in the literature examined here, is concentrated in three countries with strong forest products sectors, namely Finland, Canada, and Sweden. The remaining studies come from other European countries such as England, Germany, Romania, and Latvia. Additional examples of cross-sector collaboration undoubtedly exist but may follow different patterns in other countries and are not well documented.

The major limitation of our systematic literature review is the scarcity of work focusing on company-level collaboration (inter-sector or cross-sector) in the forest sector literature. We were unable to uncover studies describing empirical work on cross-sector collaborations. Instead, the literature is limited to theoretical initiatives on the value of cross-sector collaboration. While it is possible that this may be partially explained because of keyword choice and exclusion criteria, we argue that it is an accurate account of what exists in the literature. Accordingly, this work provides useful information on cross-sector collaboration but is only a first step in enhancing our understanding of the phenomenon.

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CHAPTER 3. COMPANY-LEVEL CROSS-SECTOR COLLABORATIONS IN TRANSITION TO THE BIOECONOMY: A MULTI-CASE STUDY

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Highlights

- Cross-sector collaboration may play a relevant role in the transition of forest sector companies toward a bioeconomy.
- Customers and brand owners are demanding to replace fossil-based products with renewable bio-based materials.
- Forest sector companies must collaborate with other industrial sectors to develop the new technologies needed to embrace the bio-product development race.
- Our findings suggest that partnering with competitors in open innovation networks may strengthen collaboration initiatives.

Abstract

Cross-sector collaboration has gained importance as a way for forest sector companies to increase innovation via novel partnerships and to identify and develop new business opportunities within the bioeconomy. Despite this, limited empirical research describes why and how forest and neighboring sector (e.g., textiles, energy, or plastics, etc.) companies choose to collaborate. This study uses a conceptual framework to document the factors and mechanisms present to increase the understanding of collaborations between forest and neighboring sector companies for developing new products. A qualitative, multi-case study is used to profile four collaboration cases involving eight companies. Two cases are collaborations where partners chose not to commercialize and two are ongoing. Results suggest that turbulent environments and desire to be ahead of competitors are the main reasons for forest sector companies to collaborate. In particular, unexpected changes, cultural and strategic fit, expected return on investment, and feasible technology availability are key drivers and challenges to the formation and sustainability of these kinds of partnerships. The study also finds that collaborations started with an early R&D process and established with startups are more likely to be successful. Findings shed

light on the elements, mechanisms, and conditions needed to implement and manage cross-sector collaborations by forest sector companies.

3.1 Introduction

The global challenges associated with population growth, climate change, and evolving consumer demand for more sustainable products are transforming the operating environment of forest sector companies (Korhonen et al. 2018; Näyhä 2019; Toppinen et al. 2017). Forest sector companies are collaborating with industries such as energy, chemicals, packaging, plastics, and textiles, among others, to develop greener products and to maintain competitiveness in the market (Bauer et al. 2018; Pelli et al. 2018). These collaborations are implemented to answer the needs of consumers and brand owners to replace fossil-based materials with forest-based resources and are gaining increasing attention as a transition pathway to the bioeconomy (Bauer et al. 2018). Collaborations present a significant opportunity for established forest sector companies to develop new technologies and production processes, explore new markets, increase competitiveness, reduce greenhouse gas emissions and human dependence on fossil-based products with sustainable bio-innovations (Pelli et al. 2018; Wohlfahrt et al. 2019). Still, little is known regarding cross-sector collaborations (CSCs) involving forest sector companies (Hansen et al. 2018; Korhonen et al. 2017). The following quote illustrates the potential relevance of CSCs for forest sector companies.

> This [CSC] is a mindset that needs to be nourished and fed in the company, if we want to play an important role in the bioeconomy and influence other industries. So, we must keep going, we must lead by example, for other forest [sector] companies, but also in other industries that CSC is needed as well (Forest Industry Director, Europe).

Both academicians and policy makers emphasize the need for CSC in the forest industry to achieve a successful bioeconomy transition (Bauer et al. 2018; Bioökonomierat 2015; D'Amato et al. 2018; DeBoer et al. 2019; Global Bioeconomy Summit 2018; Näyhä 2019; Wohlfahrt et al. 2019). A shift to the bioeconomy also presents threats and challenges for the forest sector and its companies (Kleinschmit et al. 2014). For instance, it can increase the demand of forest raw materials by outside firms and change the forest sector companies' role to raw material providers (Kraxner et al. 2017; Näyhä and Pesonen 2014), but CSCs may help mitigate challenges and facilitate the embracing of opportunities.

Implementing CSCs presents myriad challenges. Learning from successful examples can help managers to minimize failure or uneven results (Bryson et al. 2015). Company-level, CSC has been addressed in a variety of industries (Alexiev et al., 2016; Anand & Khanna, 2000; Enkel & Heil, 2014; Heil & Bornemann, 2018; Laursen & Salter, 2014). Nevertheless, to the best of our knowledge, limited research has empirically examined CSCs involving forest sector companies. To foster successful CSC, a comprehensive evaluation of key elements involved in these partnerships is needed (Korhonen et al. 2017; Näyhä and Pesonen 2014).

This research seeks to increase the understanding of CSCs involving forest sector companies and provides knowledge-driven recommendations for successfully implementing and managing CSCs. We use a theoretical framework proposed by Bryson et al. (2015) to document the factors and mechanisms regarding partnership success via four cases involving eight companies. Company-level is the most suitable scope for assessing collaborations between unlike sectors when little is known

regarding motivations to collaborate (Alexiev et al. 2016). The following research questions are addressed in this study:

- How are CSC relationships between companies managed?
- How does CSC impact new product development, innovation, and competitiveness of forest sector companies?
- What cultural changes do forest industry managers see as necessary to encourage CSC?

This study contributes to several streams of literature. First, in the forest sector literature, it enhances our understanding of why and how forest sector companies collaborate with other industries and how pursuing these novel collaborations can help them to have a relevant role in embracing and promoting the bioeconomy. Second, it contributes to the literature about interorganizational collaboration, CSC, coopetition, open innovation, and bioeconomy by explaining, using empirical data, the processes by which forest and neighboring sector companies collaborate for developing new, greener products. Third, it highlights the importance of CSC as a way for mature forest sector companies to create the novel innovations and business models needed to disrupt the forest industry and join the bioeconomy.

This paper is written from the perspective of the forest industry. We have organized it as follows. First, we provide a background of the interorganizational collaboration approaches employed, followed by the context of their application in business-to-business initiatives. Next, we explain our research methods and combine results with the discussion of our findings. Finally, we describe key study limitations, implications, avenues for future research, and provide the main conclusion drawn from this multi-case study.

3.2 Theoretical background

3.2.1 Understanding collaboration

There are many definitions of collaboration (Gray 1989, 2000; Wondolleck and Yaffee 2000; Wood and Gray 1991). Here we define it as a management process where two or more firms work together to solve problems and search for solutions beyond their limited capabilities, to achieve common goals (Gray 2000; Wood and Gray 1991). Collaboration is based on concepts such as trust, knowledge, joint learning, power, communication, and shared risks, resources, and rewards that give competitive advantage needed for better performance and success (Ansell and Gash 2008; Howard et al. 2016; Wondolleck and Yaffee 2000). In a successful collaboration, companies create value and gain competitive advantage by integrating complementary resources and learning new knowledge from partners to increase innovation (Howard et al. 2016; Ireland et al. 2002). These intangible collaboration resources are rare, valuable, cannot be imitated, and are difficult to substitute (Barney 2001; Clarke and MacDonald 2019; Lähtinen et al. 2009).

Business-to-business collaboration has been studied in several disciplines, including transaction cost economics (Williamson 1981), interorganizational systems (Kumar and Dissel 1996), strategic management (Gulati et al. 2000), service innovation (Eisingerich et al. 2009), supply chain management (Chan and Prakash 2012), services (Bell and Eisingerich 2008), and relationship marketing (Jap 2001). Most studies are focused on providing new models to assess collaboration, obtain a competitive advantage, and reduce operational costs (Howard et al. 2016). Collaboration has also become a popular strategy for companies to access

complementary resources, establish close, long-term relationships with suppliers and customers, and develop interactive relationships within and across businesses for improving performance and innovation (Wondolleck and Yaffee 2000). But, collaboration in the forest industry is complex and challenging, mainly because the industry has a traditional business culture, partners expectations are hard to meet, and it is difficult to capitalize on potential benefits (Lehoux et al. 2014).

3.2.2 The importance of cross-sector collaboration

Accelerated interest in collaboration theory has served to develop CSC literature (Bryson et al. 2015), but before the CSC literature emerged, inter-firm collaboration research described relationships between companies in a sector (Bouncken et al. 2015). CSC research covers a wide range of interorganizational relationships between businesses, businesses and governments, and businesses and non-profit organizations to create sustainable value (Alexiev et al. 2016; Andrews and Entwistle 2010; McDonald and Young 2012). The many definitions of CSC in the literature emphasize a continuum of progressively intense interorganizational relationships (Bryson et al. 2015; Murphy et al. 2015). We define CSC as, "*a management strategy used by companies to build bridges across sectors for sharing responsibilities, learning from each other, working and addressing together the challenges that companies face, as well as accomplishing outcomes and creating value"* (Guerrero and Hansen 2018, p. 1271).

Most CSC research has sought to explain motives for collaborations and the ongoing learning dynamics, best practices, outcomes and barriers, as well as provide frameworks to better understand the collaborative processes (Alexiev et al. 2016;

Anand and Khanna 2000; Enkel and Heil 2014; Heil and Bornemann 2018; Howard et al. 2016; Laursen and Salter 2014). They have also emphasized that although CSC can be complex and challenging, it may be needed more than ever (Alexiev et al. 2016). Because of the complexity and challenging dynamics of these kinds of collaborations, several frameworks have been proposed in the literature to better understand the factors and mechanisms needed in place for achieving success in CSCs (Agranoff 2012; Bryson et al. 2015; Koschmann et al. 2012).

Existing strategies and policies have emphasized CSC is needed to achieve a successful implementation of the bioeconomy, something that presents a potential benefit to companies (Bioökonomierat 2015; Global Bioeconomy Summit 2018; Näyhä 2019; Wohlfahrt et al. 2019). Company-level, CSC can enable novel bio-innovations that support sustainable development and promote new innovative products in the forest sector (Hämäläinen et al. 2011). It can help to reduce operational costs and improve environmental performance (De Loë et al. 2016). Research and sustainable innovation efforts often involve collaboration between actors in the forest industry (Bugge et al. 2016), but there is a lack of understanding regarding the role that business-to-business CSCs may play in the forest industry in their transition to the bioeconomy (Korhonen et al. 2017; Näyhä 2019; Näyhä and Pesonen 2014).

CSC has also become a source for companies to partner with their competitors in open innovation networks to gain joint benefits, including shared risks and costs, and collaborative innovation. This phenomenon is called coopetition (simultaneous collaboration and competition between rival firms) (Bengtsson et al. 2016; Gnyawali

and Park 2011; Ritala et al. 2014). A well-known example of this concept is the AIM alliance (Apple, IBM, and Motorola), where direct competitors in the computer market team up for creating a new type of microprocessor chip for laptops (Ritala et al. 2014). Coopetition research is based on competition, cooperation, and game theories (Bengtsson et al. 2016). It is employed for assessing and understanding how dynamics of collaboration between rival-companies unfold and develop, and their implications (Bengtsson et al., 2016; Gnyawali & Park, 2011; Klimas, 2016). Coopetitive relationships involving forest sector companies can be analyzed by assessing concepts such as value creation, tension and conflict, risks, knowledge, joint learning, competitiveness, and perceived coopetition in business models, among others (Bouncken & Fredrich, 2016; Ritala et al., 2014; Rusko, 2011). For instance, the factor of success for the long-term competitiveness and sustainability have been assessed in studies focused on coopetition in the Finnish forest industry (Rusko 2011, 2010).

Research work on coopetition and open innovation (distributed innovation processes based on purposively managed knowledge flow across the organization boundaries (Chesbrough and Bogers 2014)) are considered examples of CSCs. These can facilitate creation and transfer of knowledge between companies, improve competitiveness, bring actors to new supply chains, and create new markets (Le Roy and Chesbrough 2018; Ritala et al. 2014). Research regarding these interorganizational collaboration approaches may have an important role in the forest industry transition to the bioeconomy.

3.3 Methods

To increase the understanding of company-level, CSC, we adopted a qualitative, explanatory multi-case study design (Creswell 2014; Eisenhardt and Graebner 2007; Yin 2014). A case study focuses on a phenomenon in a defined context (Miles et al. 2014). Case studies can contribute uniquely to our knowledge of an individual, organizational, social, or political phenomena (Yin 2014). They combine various data collection methods such as literature searches, interviews, and observations (Eisenhardt 1989). They also allow for in-depth and detailed examinations of the instances, conditions, and complex relations between qualitative or quantitative data (Babbie 2012; Yin 2014). Although single-case studies are used to describe the existence of a phenomenon, multi-case studies are particularly useful to analyze the phenomenon within each case and across-cases and helps to better understand differences and similarities. Further, multi-case studies provide more robust, compelling, and generalizable bases for theory building than single cases because they enable comparison of findings and more precisely delineated relationships (Eisenhardt 1989; Eisenhardt and Graebner 2007; Yin 2014).

3.3.1 Case study design, sample selection, and unit of analysis

Our approach followed three stages. First, we carried out a pilot study with experts on collaboration and bioeconomy to identify CSC cases. Fifty-eight experts from 18 countries were contacted by email using a snowball sampling approach (Babbie 2012) and asked to provide examples of CSC involving forest sector companies. As an outcome of this stage, 18 examples of CSC were identified and placed in three categories: potential, ongoing, and past collaborations (Appendix A).

Four collaboration cases involving eight partner companies, four forest and four neighboring sector companies in Europe, Asia, and North America, were ultimately selected. The collaboration cases were chosen based on the willingness of executives to participate in the study. Two of the cases selected are past collaborations and two ongoing. We define as past collaborations those cases where partners chose not to commercialize because their expectations were not met. For the remainder of this paper, the four collaboration cases will be referred to as Alpha and Beta (past collaborations), and Gamma and Delta (ongoing collaborations). Our unit of analysis is the concept of CSC.

In the second stage, we conducted semi-structured interviews with top executives (CEOs, VPs, managing directors, etc.) from each company involved in the collaborations. Potential participants were contacted by email. In total, 19 executives (11 North Americans and 8 Europeans) from 26 contacted, agreed to be interviewed. Those who declined cited lack of time and/or early participation in their respective collaboration as reasons. In the third stage, secondary data in the form of company reports, strategic presentations, press releases, and literature sources were gathered to complement the information from the interviews (Miles et al. 2014). Figure 3.1 illustrates the structure of the multi-case study design adopted.

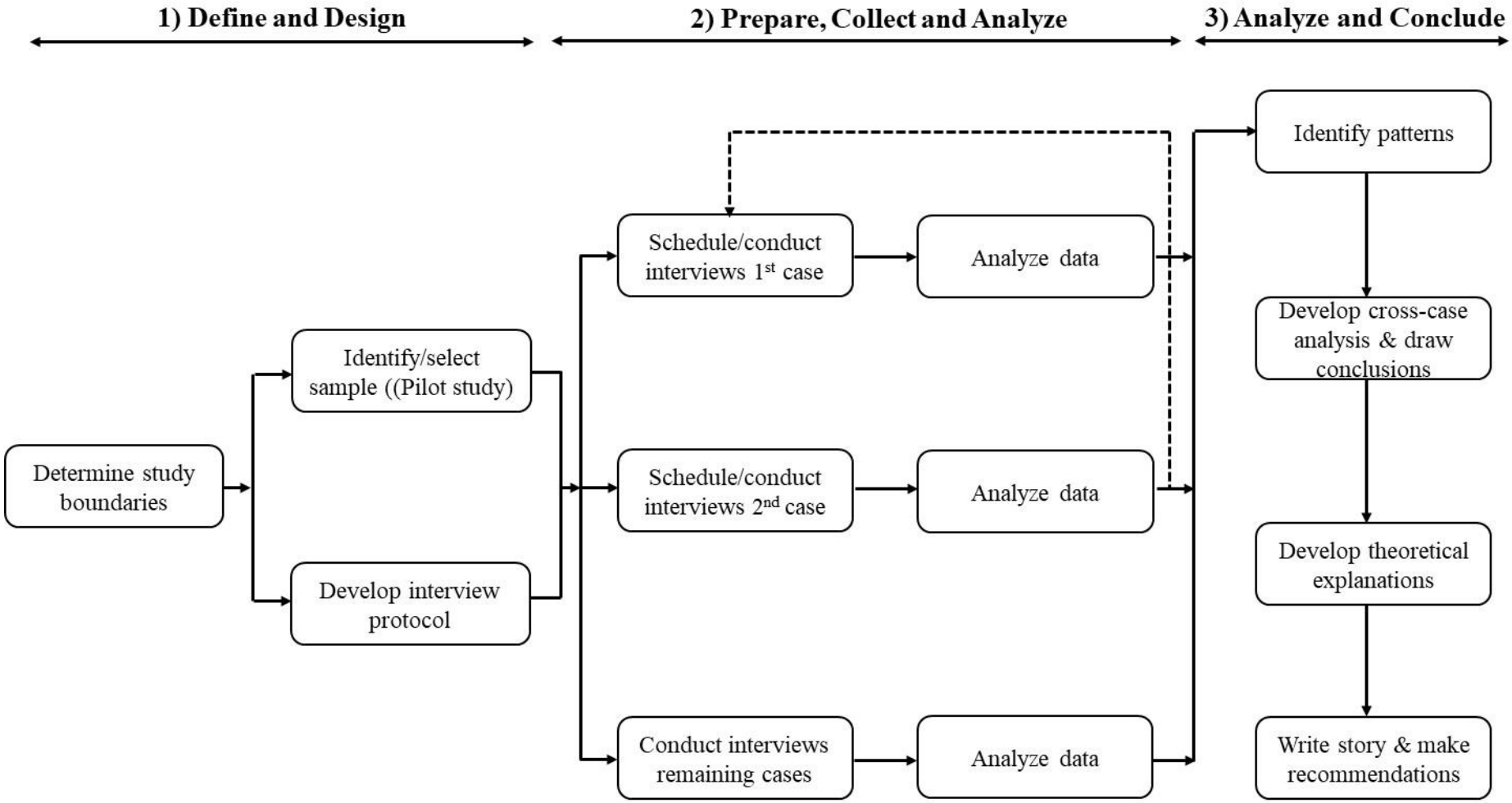

Figure 3.1. Multi-case study research: Design and procedure (Modified from Yin 2014).

3.3.2 Data collection

We used semi-structured interviews because they engage participants in a neutral manner, reduce question bias and increase reliability, and allow for follow up questions on topics of interest (Babbie 2012). Interviews were conducted either in-person, by phone or by Skype, in English. Between two to four executives were interviewed per company. The interview protocol was created based on existing literature on CSC (Bryson et al. 2015; Crosby and Bryson 2010; Gray 2000; Gray and Purdy 2018; Guerrero and Hansen 2018; Howard et al. 2016), and deliberation between the authors (see Appendix B). The same questions were followed in each interview to allow cross-case comparability (Miles et al. 2014). The protocol was reviewed by six researchers with expertise in collaboration and qualitative research. This review resulted in minor changes. The first author reviewed relevant information related to each company and case example selected before conducting interviews to avoid misunderstanding concepts and personal bias (Berry 2002; Woodside 2016).

Interviews were conducted between December 2018 to January 2019 in North America and during February 2019 in Europe. Interviews lasted from 35 to 75 minutes. All interviews were audio-recorded, then transcribed and coded. Transcripts were reviewed by a second person prior to analysis to ensure accuracy (Patton 2002). Handwritten notes were taken during interviews to support the audio records and were used to formulate follow-up questions, check with interviewees for clarification, describe relevant quotations, facilitate transcription and coding, enrich data analysis, and verify the conclusions drawn. This helped to improve validity (Patton 2002; Yin 2014). Finally, a preliminary simultaneous analysis was carried out during data

collection to focus the interview strategy according to the emerging data and enrich the data collection and analysis processes (Maxwell 2009; Patton 2002).

3.3.3 Data analysis

Data were analyzed and interpreted following a three-step technique suggested by Miles et al. (2014): data reduction, data display, and conclusion drawing and verification. In step 1, interview transcripts were read and coded (data reduction) by the first author using the software NVivo 12. In step 2, data were summarized and displayed in comprehensive matrices and tables to identify within- and across-cases similarities and differences, conclusions, and comparisons to the theoretical background (Miles et al. 2014; Stake 2006; Yin 2014). We conducted a cross-case comparative analysis of the four collaborations supported by detailed matrix analysis procedures (Miles et al. 2014; Yin 2014). In step 3, we identified links and connections among themes, drew initial conclusions and verified with secondary data sources to ensure their validity.

The coding process was conducted in three cycles (Miles et al. 2014). The first cycle was carried out using three predefined themes: collaborative process, actual/potential benefits, and organizational environment; which were based on our research questions. During this cycle, 34 codes were created. The second cycle was conducted to find patterns by categorizing and collapsing the earlier codes from the first cycle to a refined initial number of themes (11) to facilitate interpretation. When new codes and patterns were identified, those were added to the analysis. A third cycle was done combining the first and second cycles. It helped to refine the initial categories resulting in eight final themes (Figure 3.2). In all cycles, memo writings

were used to document the process, keep track of codes and improve coding analysis (Maxwell, 2009).

To assess coding reliability, the second author coded two of the interview transcripts using the codes initially created. The sample transcripts were randomly selected, and coded manually, without discussing the coding process with the first author. Intercoder reliability was calculated with NVivo12 software by using Cohen's Kappa coefficient. It measures the agreement between two coders who each classify a number of items into mutually exclusive categories. The software compares these agreements and disagreements between coders in the assignment of codes to segments of the interview transcript (Miles et al. 2014). The first test showed substantial agreement between coders ($K = 0.64$, the goal was $K \geq 0.85$). Then, we compared results and discussed coding differences where there were discrepancies. The first author then trained the second author, discussed the coding scheme, explained how it was developed and how transcripts were coded. Based on this process, the second author again coded the interview transcripts. We compared results and discussed differences in coding judgments, then merged some codes and reduced the initial number created (Campbell et al. 2013). Finally, we achieved a Cohen's Kappa value of 0.90, indicating excellent reliability (Miles et al. 2014). After this stage, the first author re-coded all interviews transcripts in the first coding cycle and conducted the second and third cycles.

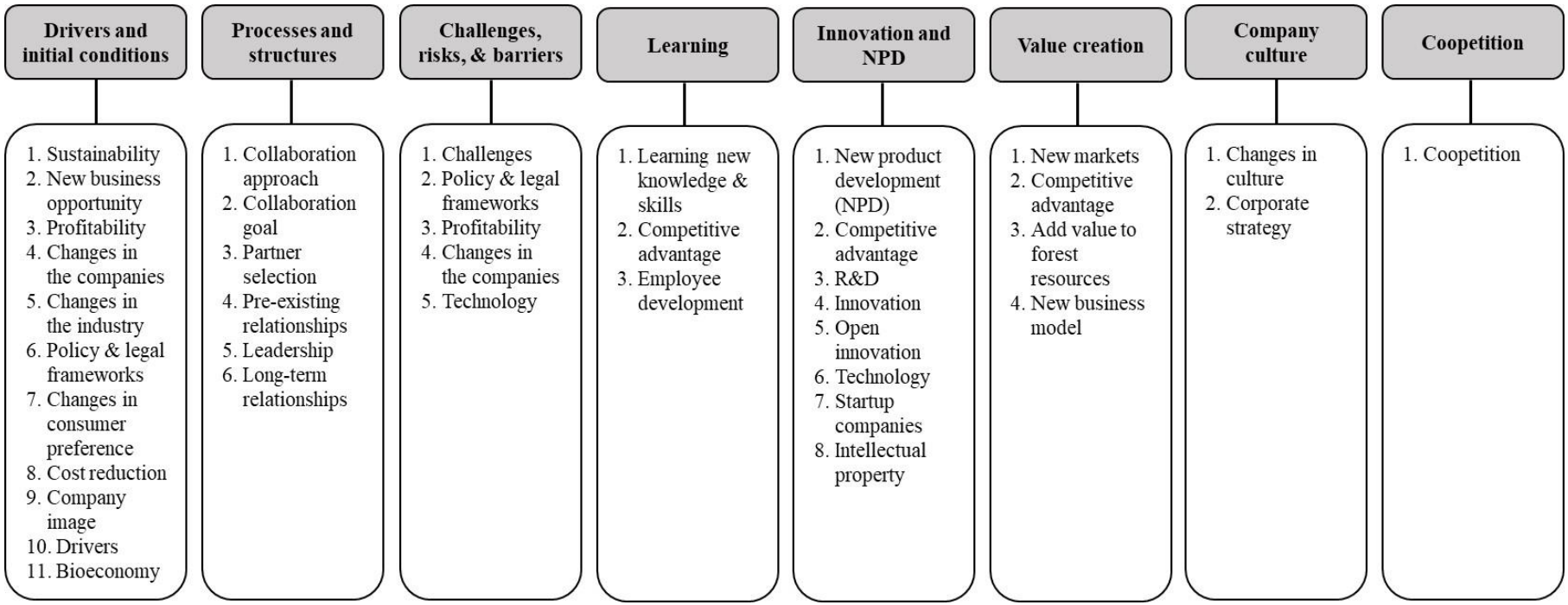

Figure 3.2. Emerging primary and secondary themes identified during data analysis.

Note: Primary themes are listed in the top from left to right following the collaborative framework adapted. Secondary themes (individual codes) are grouped under their corresponding primary theme and sorted by frequency with those listed first as the most frequently coded.

Because there are several risks associated with the objectivity of qualitative information from case studies, we adopted various actions to prevent researcher bias in the analysis of the data and evaluate the quality of the research findings (Miles et al. 2014; Yin 2014). We used data triangulation as the primary method for minimizing researcher bias. Triangulation is considered the most common technique employed to prevent researcher bias in qualitative studies. Triangulation happens when multiples sources of evidence support or do not contradict the conclusions drawn by the researchers (Miles et al. 2014). Interview information and data obtained were triangulated with various sources such as company reports, press releases, and websites, etc. Table 3.1 shows a description of some additional measures that were adopted during the study design, data collection, and data analysis to ensure validity and reliability (Yin 2014).

Table 3.1. Measures taken in the research study to improve validity and reliability.

Tests / Phase of research applied	**Actions taken by researchers**
Construct validity (Data collection and data analysis)	– Different data sources were used (data triangulation) – Chains of evidence were developed – Method and techniques are clearly documented and described
Internal validity (Data analysis)	– Intercoder reliability was calculated – Memo were written during the coding analysis – Matrices and tables were used for individual and cross-case analysis – A cross-sector collaboration theoretical framework was used
External validity (Research design and data analysis)	– Multi-case study design was adopted (replication logic, and cross-case comparability) – Findings are consistent with previous research and literature – Anonymity of interviewees and case companies was guaranteed
Reliability (Data collection)	– A study protocol and database were elaborated – Established qualitative methods were employed

3.4 Results and discussion

Table 3.2 provides an overview of the four collaboration cases, industrial sectors, and eight companies involved, as well as a description of the type of positions held by those interviewed. In all cases, executives expressed that the forest sector companies have had no previous experience collaborating with other industries, unlike the companies they partnered with. In the following, we discuss each of the primary themes identified (See Figure 3.2) and present a model for understanding CSCs involving forest sector companies, based on the framework proposed by Bryson et al. (2015). Figure 3.3 provides a visual representation of the CSC model. It illustrates the categories, concepts, elements, mechanisms, and findings under which these collaborations are implemented and managed. This section introduces the framework and its main components. All quotations in the text below come directly from interview transcripts.

3.4.1 Drivers and initial conditions

CSCs are more likely to form in turbulent environments. In all cases, executives emphasized that the minor crises and unexpected changes in the organizational environment faced by their corporations are the initial conditions that favor the formation of CSCs. They stated that there were external forces such as loss of market share, declining demand, growing competition, and changes in regulations and policies that motivated partnering with businesses outside of their sector. Unpredictable changes in the organizational environment are a key aspect in both the implementation and sustainability of CSCs (Bryson et al. 2015; Simo and Bies 2007). The need to identify new business opportunities, develop greener products, increase

profitability, and shift corporate strategies were considered the principal internal drivers. Value creation and societal need for replacing fossil-based materials using forest-based resources are both strong drivers of CSCs (Bauer et al. 2018; Murphy et al. 2015).

Interviewees in Delta also highlighted that a shift in consumer preferences and the growing bioeconomy were considered additional drivers for collaboration. They reported a strong demand for more sustainable products from customers and brand owners that are driving value chains in industries such as textiles. CSC has been highly emphasized in bioeconomy discussions and studies as a means for forest sector companies to be more competitive (Hansen et al. 2018). Although some studies describe an industry where collaboration is neglected, even inside of the sector (Näyhä and Pesonen 2014; Orozco et al. 2013), others show an industry where companies have a positive attitude toward collaboration (Hämäläinen et al. 2011; Mattila et al. 2016; Näyhä 2019).

> It has been clear to us that the world is changing. And partly it's opening new opportunities, people call it the bioeconomy, where consumers are asking for products which are made of renewable raw materials more than they were asking for them 10 to 15 years ago, and this trend is most likely becoming stronger (Forest Industry CEO, Europe).

> …the real driver was a new law passed about certain levels of renewable biofuels that would be in certain streams going out into the future. So, if petroleum companies did not meet these quotas they were to be fined. So that was a strong economic pressure on those companies to be able to produce biofuels, but they didn’t have the knowledge of where to get the feedstocks for it (Forest Industry Senior Researcher, North America).

Table 3.2. Multi-case study data sources and general information.

	Past collaboration		**Ongoing collaboration**	
	Alpha	**Beta**	**Gamma**	**Delta**
Companies involved	Forest company Energy company	Forest company Energy company	Forest company Energy company	Forest company Textile company [a]
Started	Pre-great recession	Pre-great recession	Post-great recession	Post-great recession [b]
Data sources	Interviewees [c]: - 1 President and CEO - 1 VP, Research and Development - 2 VP, Technology - 1 Commercial Development Manager - 1 Director of Communication - 1 Senior Research Scientist	Interviewees [c]: - 1 VP, Research and Development - 1 VP, Group R&D Innovation - 1 VP, Research and Technology - 1 Program Manager R&D - 1 Business Development Director - 1 Senior Associate R&D	Interviewees [c]: - 1 General Director (President/CEO) - 1 CFO - 1 Senior VP, Resources - 1 Director SBD	Interviewees [c]: - 1 President and CEO - 1 Senior VP, Business Development
Collaboration type	50/50 Joint venture company	50/50 Joint venture company	50/50 Joint venture company	50/50 Joint venture company
Collaboration goal	Develop technology and produce biofuel using forest-based residues	Develop technology and produce biofuel using forest-based residues	Produce biofuel using forest-based residues	Produce textile from wood fibers.

[a] We were not able to interview executive members of the textile company involved in the collaboration.
[b] The Great Recession was a global economic decline observed in world markets during the late 2000s and early 2010s (O'Malley et al. 2011).
[c] Type of position held by interviewees: President and Chief Executive Officer (CEO) (2); General Director/CEO (1); Chief Financial Officer (CFO) (1); Senior Vice President (VP), Business Development (1); Senior VP, Resources (1); VP, Research and Development (R&D) (2); VP, Group R&D Innovation (1); VP, Research and Technology (1); VP, Technology (2); Commercial Development Manager (1); Program Manager R&D (1); Director Strategic Business Development (SBD) (1); Business Development Director (1); Director of Communication (1); Senior Research Scientist (1); Senior Associate R&D (1).

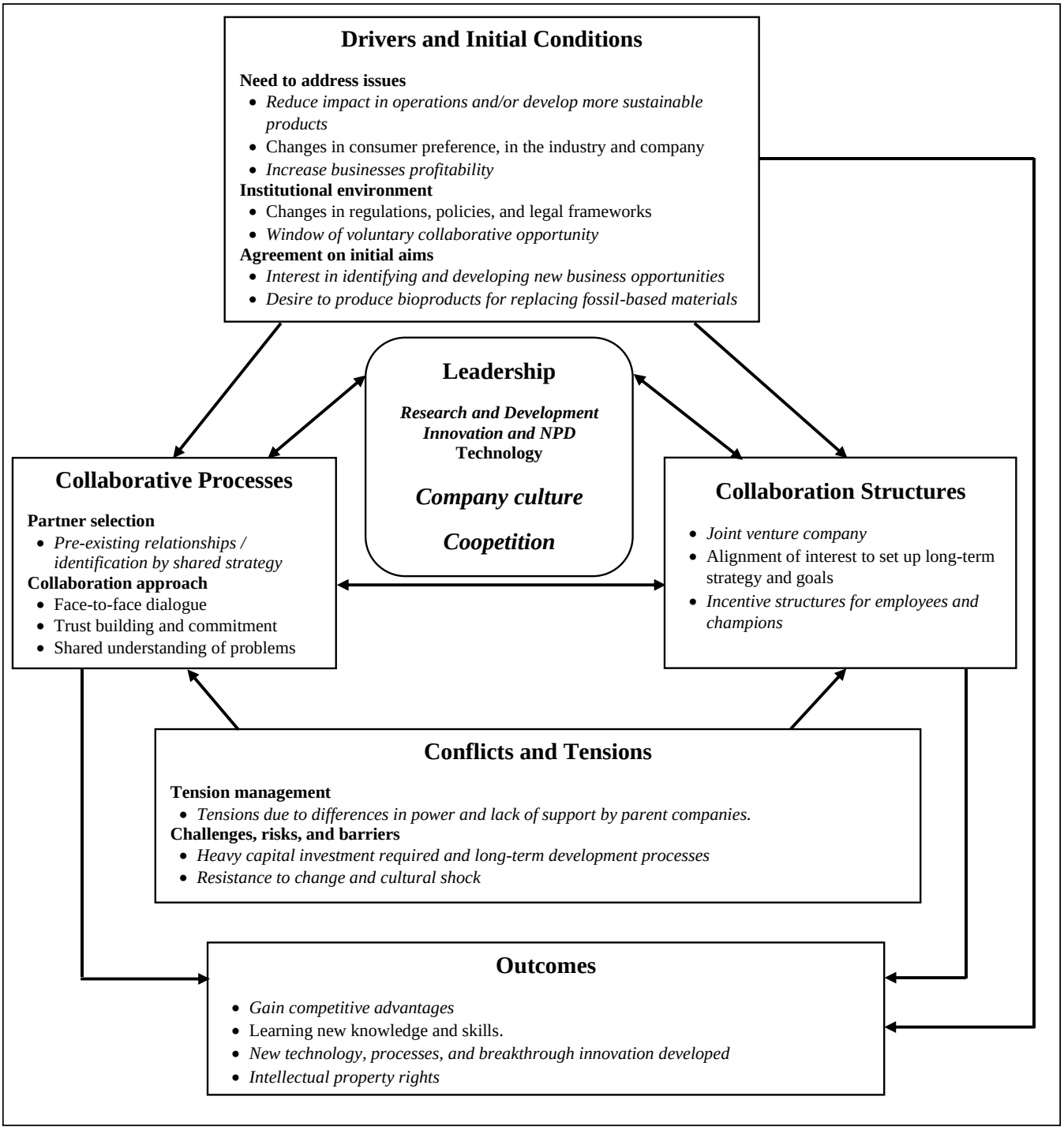

Figure 3.3. Conceptual framework for understanding cross-sector collaboration (modified from Bryson et al. 2015).

Note: The italicized text illustrates new categories, concepts, and factors added by the authors from the empirical findings.

Executives from Alpha and Beta stated that the collaborations were implemented by their companies seeking to share and reduce costs, improve corporation image, and add value to forest-based residues and the entire forest value chain. Executives of Alpha, Beta and Gamma reported these collaborations were implemented not only to solve challenges, but also because leaders thought they would allow their companies to bring in like-minded partners (those that share similar values, strategies, and goals (Melander 2017)) with complementary skills (partners who have dissimilar knowledge and skills (Ollila and Yström 2017)). Executives stated that having complementary skills among partners can allow them to develop new products, embrace changes, and have successful collaborations (Chambost et al. 2009). These findings contrast with those reported by Velenturf (2016) and Knudsen (2007) on collaborative product innovation. They suggest that companies prefer to partner with organizations in their own sector due to their high degree of overlapping skills. Like-minded and complementary partners are considered key to success in collaborative innovation processes (Chambost et al., 2009; H. W. Chesbrough, 2011).

> We are always looking for like-minded partners, this is a key success factor. We don't collaborate with companies that don't share our core values. If they appreciate sustainability and innovation and are customer centric. We find ways to collaborate (Forest Industry Director, Europe).

> If you can partner with a company that brings expertise that you don't have, that provides a significant advantage. If the skills are complementary, not overlapping, you can always talk about new products and a new way of using forest feedstock, technology, and increase your value (Energy Industry CFO, North America).

A link between initial conditions and collaboration success was identified among the case studies. Collaboration starting with an early phase of research and

development (R&D) and open innovation before the partnership was set up (Gamma and Delta) have higher probability to be commercialized than those that were established to develop and demonstrate new technology (Alpha and Beta). Gamma and Delta were implemented after developing early research projects with universities and cross-sector partners from other industrial value chains. This has resulted in new technological developments and a better understanding of production processes and customer needs. By contrast, Alpha and Beta were established for developing and demonstrating a new technological process for converting forest resources into bioproducts, mainly by doing in-house R&D. Related work by Korhonen-Sande and Sande (2014) and Näyhä and Pesonen (2014) found that collaborations carried out through R&D projects with research institutes, universities, and corporations are more likely to succeed. Table 3.3 summarizes findings regarding the main drivers, challenges, and outcomes identified within the four collaborations.

3.4.2 Implementing and managing collaboration processes and structures

Several conditions were presented to guide the design, implementation, and management of the collaboration processes and structures. Collaborations were planned following two steps, partner selection and process set up. Partner selection was done considering different strategies. Executives in Alpha and Delta stated that collaborations were initiated based on pre-existing relationships among employees and companies. Executives in Beta and Gamma mentioned that partners were selected based on several aspects, including complementary skills, mutual trust and commitment, and shared strategies and goals among companies regarding innovation. Selecting the right partner and partnership model can provide sustainable competitive

advantages and reduce risks in CSCs (Chambost et al. 2009). But, overcoming lack of trust and finding compatible and committed partners are managerial challenges in collaborations with forest sector companies (Lehoux et al. 2014). The importance of trusted and committed partners is recognized by various studies in the forest sector (Mattila et al. 2016; Näyhä and Pesonen 2014; Zander et al. 2016). Our results suggest that they also play a crucial role in forest sector companies regarding partner selection in CSCs.

> I think if you can partner with a group or a company that brings expertise that you don't have, that provides a significant advantage. But you need to make sure that the economic value that you get out of it makes sense. If I can make one dollar. When I team up with somebody, I would like to make two dollars more. Then, I realize that I can make three dollars. (Energy Industry CFO, North America).

The structures highlighted by all interviewees include factors and mechanisms necessary to reach agreements on collaborative goals and actions (Koschmann et al. 2012). Executives reported that a joint venture was selected early as the arrangement and business model between corporations. The new entities were created following all formal, conventional agreements needed to establish a company (e.g., the shareholder agreements). Some executives indicated that limited liability companies were the type of legal structure used by the corporations to form the new entity. They also described that a joint venture was chosen because of the long experience of the non-forest companies doing it, as well as the partners' interest to mitigate management risks, create joint teams, and achieve long-term collaborations. Interviewees of Alpha and Beta reported that teams were established with seconded individuals (employees temporarily assigned to another subsidiary or different employer within their corporation (Kolympiris et al. 2019)) from the parent companies. However, they

stated that this practice may present confusion for the employees in aspects related to the sense of belonging, salary actions, performance reviews, etc. Executives of Gamma described that the alignment of interest for stakeholders to participate in collaborations (cost reduction, etc.) and what incentivizes employees and champions (holiday compensations, promotions, etc.) were also elements presented (Bryson et al. 2015).

> So, you can create a collaborative culture. However, you've got to create incentives and clear contracting with your employees and every member of the joint venture that this is what we're doing, and this is how we're moving forward. If you don't do that, your probability of success diminished significantly (Energy Industry CFO, North America).

3.4.3 Challenges, risks, and barriers

Myriad challenges were described by interviewees. The heavy investment required, mainly due to the high cost of developing new technology, as well as the unexpected increase in capital expenses, were described as significant challenges in all collaborations. Some executives pointed out that attempts to develop this type of technological process involves high risk because there is no certainty that it would be feasible, it is capital-intensive, and may take longer than expected to realize the business case. They also affirmed that increases in capital expenses makes it almost impossible by corporations to recover their investments within a reasonable time.

> I think the biggest challenge is the fact that the technology is unique and new. So, there is no certainty that it will work. So, that is the thing that I worry most about (Forest Industry CEO, Europe).

> I think that one of the barriers was that it takes longer than what we think. Because, what we were trying to do, it was working, and it was trying to commercialize new technology (Energy Industry VP, North America).

The absence of consistent government policy and regulatory support was considered a key barrier for implementing the collaborations in Alpha, Beta and Gamma. Interviewees expressed that shifts in policy and legal frameworks, lack of incentives and mandates, and increase in lobbying against the development of new forest-based products are challenging not only to formation but also to the sustainability of collaborations. Some executives noted that these kinds of collaborations are too dependent on regulation and vulnerable to changes in policy and/or politics, as well as changes in the industry or in the company strategies and dynamics.

> …it has to do with our product, qualifying for incentives, and all the regulatory hurdles that need to go through. And the fact that the EPA [The US Environmental Protection Agency] changes its mind quite a bit (Energy Industry CFO, North America).

> We saw that biofuel was too much regulation dependent. We thought it was not a good business because it needed the regulation to back it up. We focused on replacing plastics that have a bigger impact on the environment, and it's not regulation dependent (Forest Industry VP, Europe).

Executives of Alpha and Beta described that lack of economic feasibility and inadequate return on investment are the main reasons why the ventures were not commercialized. The lack of viable technology, low yields, difficulties in converting forest-based residues, and high production costs, among others were reported as challenging for ensuring their profitability. Beta executives reported that although the collaboration technically worked, it would not have been economically feasible even with subsidies. These challenges resulted in economically inviable business cases that were not marketed. On the other hand, executives in Gamma and Delta claimed that the long-term technological development, changes in the management of the

companies, and return on investment expectations are considered barriers to commercialization. These two cases have high viability to be commercialized in the future, but the identified challenges can lead to competitive uncertainties in the future marketing of final products.

> There wasn't really proven technology, there were a lot of conversion technology companies, with promises out there, but they were in early pilot stages. And no one could ever prove in these technology companies that they could really do this conversion at scale. We were missing the piece in the middle, the technology, to convert the feedstocks into biofuels (Energy Industry CEO, North America).

> …there was a great deal of enthusiasm about the technology and how effective it could be. But it turned out that the technology was very difficult and expensive. It felt like the product to be developed would have prices around $200 dollars a barrel to justify it. And it was when we had oil at $120 or $130 dollars a barrel (Energy Industry Manager, North America).

Executives of Alpha reported that in the initial years of the collaboration, there was a lot of tension between the boards of directors and the venture company CEO regarding what the new entity wanted to do and what it can do. One interviewee described that it was perceived as two different parties pushing back and forth. Similarly, executives of Alpha and Gamma highlighted that the lack of energy and interest of some leaders and employees were other challenges faced in these collaborations. An executive emphasized that keeping everybody pulling in the same direction and goals has been very challenging for them. A critical challenge that was illustrated by forest executives at Beta is power relations and conflicts (Bryson et al., 2015). They stated that mature forest sector companies need to prove the value they bring to collaborations to ensure a win situation when they are partnering with large corporations. Nevertheless, these tensions were considered as minor challenges and

part of the learning process in CSCs involving forest sector companies. A summary of the main challenges identified in all collaborations can be found in Table 3.3.

Differences between challenges identified and collaboration success were explored for the four case studies. Our findings suggest that in Alpha and Beta, the lack of consistent policy and legal frameworks, power conditions, and consumer willingness to pay for using bioproducts influenced the decision not to market the initiatives. Further, the early-stage, expensive, and complex development of the technology proposed were additional reasons that pushed the parent companies to end both collaborations. Some of these conditions have also been barriers for Gamma and Delta collaborations. However, the fact that these initiatives were implemented for demonstrating licensed technology rather than to develop it through the collaborations may give them higher viability to be commercialized. Similarly, the increase in social concerns, public involvement, and lobbying to reduce the dependence on fossil-based products, as well as the shift in strategies, policies, and consumer preferences for using more sustainable products globally indicates a need for these kinds of initiatives in the market (Bauer et al. 2018; Pelli et al. 2018).

Table 3.3. Drivers, challenges, and outcomes associated with cross-sector collaborations involving forest sector companies.

Categories	Past collaboration		Ongoing collaboration	
	Alpha	**Beta**	**Gamma**	**Delta**
Drivers and initial conditions	• Sustainability • Minor crisis & changes • Pre-existing relationships • Be ahead of the competition • In-house R&D	• Sustainability • Minor crisis & changes • Shared strategy and goals • Be ahead of the competition • In-house R&D	• Sustainability • Changes in company environment • Shared strategy and goals • Be ahead of the competition • Early R&D phase and open innovation	• Bioeconomy • Changes in company environment • Pre-existing relationships • Be ahead of the competition • Early R&D phase and open innovation
Main challenges	• Capital-intensive investment • Lack of consistent policy • Changes in company strategy • Inadequate return • High costs and low yields	• Capital-intensive investment • Lack of consistent policy • Employees' resistance to change • Inadequate return • High costs and low yields	• Capital-intensive investment • Lack of consistent policy • Changes in company strategy • Long-term development • Increase in expenditure & competitive uncertainty	• Capital-intensive investment • Lack of clarity of competition law • Culture shock • Long-term development • Increase in expenditure & competitive uncertainty
Main outcomes	• New knowledge and skills gained • Trusted long-term relationships • Not interested in collaborations • New product developed • Competitive advantage gained • Add value to forest residues • Intellectual property rights • Technology not developed • Collaboration was ended	• New knowledge and skills gained • Trusted long-term relationships • Changes in culture and strategy • Open to collaborate • New product developed • Competitive advantage gained • Add value to forest residues • Intellectual property rights • Technology developed; but complex and not viable • Collaboration was ended	• New knowledge and skills gained • Trusted long-term relationships • Changes in culture and strategy • Open to collaborate • New product developed • Competitive advantage gained • Add value to the forest supply chain • Intellectual property rights • Technology & breakthrough innovation developed • Process is a demonstration-scale	• New knowledge and skills gained • Trusted long-term relationships • Changes in culture and strategy • Open to collaborate • New product developed • Competitive advantage gained • Add value to the forest supply chain • Intellectual property rights • Technology & breakthrough innovation developed • Process is a demonstration-scale

3.4.4 Outcomes

3.4.4.1 Fostering learning through cross-sector collaborations

Learning new knowledge and skills or joint learning (Bryson et al. 2015; Howard et al. 2016) was highlighted by all executives as one of the most valuable collaboration benefits. Executives in Alpha and Beta described that although the collaborations were not marketed, the parent corporations gained knowledge, information on different technologies, and technical know-how for producing bioproducts. They claimed their companies have learned from past experiences and are aware of what they can or cannot do in these areas. They also emphasized that the knowledge and skills gained are applied to other processes and businesses. This process is known as absorptive capacity, the ability of companies to recognize the value of new information and apply it for commercial purposes (Gupta and Govindarajan 2000; Nilsson et al. 2017; Todorova and Durisin 2007). Similarly, interviewees in Gamma and Delta expressed that both employees and companies are consistently gaining knowledge and know-how. A forest executive reported that they are constantly learning about new management skills, how to develop and improve technology, build collaboration agreements, and manage relationships. These learning processes may lead to opportunities for companies to enhance their absorptive capacity (Gupta and Govindarajan 2000), obtain difficult-to-imitate resources and a long-term competitive advantage (Barney 1991), and ensure business success (Hämäläinen et al. 2011). Organizations that possess these capacities are better collaborators (Van Lancker et al. 2016).

> …many of my colleagues described how much we both [the parent companies] learned. It opened up our ways to work. At the engineering

> level, a lot of specific things, how to run an R&D project, how to plan, how to follow up, how you decide when you move ahead. Because our partner was very precise in these. And these are secondary compared with the big picture [produce biofuel from forest biomass], it was very good learning (Forest Industry VP, Europe).

> …we've taken a lot of the lessons learned with our partnership, and apply that to you know, future and current business opportunities (Forest Industry VP, North America).

Sharing knowledge and resources was also emphasized by all executives as an additional advantage for companies partnering with other industries. Companies are collaborating with other industries because it helps them to obtain expertise and knowledge that they do not possess and develop more successful processes. Some executives reported that they choose to collaborate because they do not have the resources or know-how internally to build that type of technology. Collaboration has provided partners considerable information on all factors needed upstream and downstream to produce and commercialize biofuels. This new knowledge gives companies a unique asset and competitive advantage because they have acquired intangible resources and competencies that are valuable and difficult to imitate by their competitors. These competencies are consistent with the resource-based view of the firm (Barney 2001; Clarke and MacDonald 2019). Further, some executives reported that sharing resources such as information, workspaces, and employee skills and expertise have helped partners to build trust and focus the collaboration on transparency and openness. One executive mentioned that he was very impressed with how transparent their collaboration was because companies were sharing all data and information.

> …we don't have the knowledge to do it alone. If we had done it alone, it would take us 10 years to build it up, and 100 million dollars or

> more. And then it might be the wrong one. That's why in these instances, we have to share the information (Energy Industry Manager, Europe).
>
> …we understand that we don't have all the knowledge, that the others have something, and quite a lot actually. We also need to have some kind of openness that when collaborating, we have to share our knowledge also with the others (Forest Industry VP, Europe).

Each collaboration included a strong focus on employee development, which is one of the crucial success factors. Most executives claimed that employee development was seen as another of the most important assets obtained by parent companies. Executives reported that employees involved in these collaborations have a lot of exposure, get visibility inside and outside of the companies, acquire extensive training and new skills, and are very enthusiastic and proud of being part of it. Some interviewees affirmed that having taken part in these collaborations is very exciting and one of the most pleasant experiences in their careers. One respondent highlighted that these partnerships also help companies to retain, develop, and attract new talent because they involve a lot of learning (Austin 2000). Employee development and experience have been emphasized as an important benefit of inter-firm collaboration in the forest industry (Lähtinen et al. 2009; Toppinen et al. 2011). Both are considered a competitive advantage by companies because they are rare and difficult to imitate or substitute (Barney 1991; Lähtinen et al. 2009).

> …it was probably the most enjoyable part of my 40-year career. I got to meet and work with people who had different backgrounds and areas of expertise and try to work hard with them to accomplish something difficult. I also developed a sense of identity of being part of something new and unique that any company had never done (Forest Industry Senior Researcher, North America).
>
> There is a lot of learning in a collaboration and it is also a way to retain and develop talent in the company. Because it [development] is very interesting for millennials. I mean, these partnerships are really

> interesting for someone to manage, there is a lot of learning, to get in contact with other industries, you are not isolated. So, it's extremely interesting and ambitious, and the exposure is very diverse. This kind of partnerships to accelerate innovation, is also a way for us to retain and attract talent (Forest Industry Director, Europe).

Learning is an important feature for achieving success in CSCs (Bryson et al. 2015). While the potential for obtaining new technological know-how and skills from partners has been well documented (Ansell and Gash 2008; Gupta and Govindarajan 2000; Howard et al. 2016; Van Lancker et al. 2016), there are other benefits that highlight the value of these collaborations. Our results suggest that learning in partnerships with industries that have particular expertise in organizational innovation and new product development may benefit the innovative pursuits of forest sector companies. These learning opportunities should be considered by companies when selecting partners as describe in the following section.

3.4.4.2 Innovation and new product development in cross-sector collaborations

CSC has become a major driver for forest sector companies to increase innovation and develop new products (Toppinen et al. 2017). Executives of Alpha and Beta reported that these collaborations were initiated by doing internal R&D projects and followed by working with third parties later, mainly universities and startup companies. On the other hand, forest executives in Gamma and Delta emphasized that abundance of novel knowledge, expertise, and business opportunities outside of their company boundaries have pushed them to collaborate with other industries. CSC has received high priority on bioeconomy studies as a means for forest sector companies to increase innovations and the development of new product portfolios (Bauer et al. 2018; Hämäläinen et al. 2011; Näyhä 2019; Näyhä and

Pesonen 2014). Thus, collaboration with different industries and actors are required by mature forest sector companies to expose their employees to new know-how and ideas, go outside their exploitation culture, and create an exploration structure in transition to the bioeconomy (Hansen 2016).

> It became a recognition that there was plenty of process around that would be patented by dozens, if not by hundreds of startup companies. One could probably reach out one by one, or invested in one, or collaborate with one a at future date (Forest Industry VP, North America).

> We need to find those ideas and organizations that come from outside of our sector and be part of or invite them to our network. And then start working on these new products and reaching the new market (Forest Industry CEO, Europe).

The interviewees highlighted that these collaborations were considered as cases of breakthrough innovations (O'connor and Rice 2001). They emphasized that the companies were involved in these novel collaborations because they thought that these initiatives would allow them to stay ahead of their competitors. Executives in Alpha and Betta reported that although their parent companies wanted to leave the competition behind, there was no way they could do it because collaborations were not financially viable. Forest executives of Gamma and Delta claimed that these kinds of collaborations can provide their companies with a competitive edge in new value chains and markets similar to what they have in the forest value chains. However, all interviewees stressed that these collaborations provide their companies with a competitive advantage. They stated that parent companies, for example, keep all the intellectual property rights (e.g., patents portfolio), technical know-how, and information gained to develop new and improve existing processes, products, and businesses. Most breakthrough innovations are created combining new knowledge or

ideas between fields (Kloiber and Priewasser 2014). Collaboration between different industries is needed to access this complex knowledge and enable diffusion of sustainable innovations (Van Lancker et al., 2016).

> The companies were trying to do real breakthrough innovation. And they've studied breakthrough innovation and how people used to forget about the critical thing. It is all the technical, market, and management risks. And they decided to set up a joint venture as a way to mitigate some of the risks, which are going to account as things go slower with the breakthrough innovation (Forest Industry VP, North America).

> …we were calculating that we will be approximately minimum three years ahead of our competition. We have realized that they [competitors] follow us five to seven years later. And that [collaboration] has brought really stability for the company to be number one in the business. The only one in the world that is producing renewable diesel (Energy Industry VP, Europe).

Most forest executives illustrated that these collaborations have made forest sector companies cooperate in R&D and open innovation projects with external organizations and actors such as universities, research institutes, suppliers, customers, startups, other companies, and even their competitors. These executives described that companies take part in these projects for finding new ideas and know-how from outside organizations that can hopefully become innovations, incremental or radical. They also reported that licensing technology from or investing venture capital into startups is another alternative to find new ideas that can become novel innovations, technological processes or products (Näyhä, 2019). One respondent stated that it is needed for forest sector companies to collaborate with universities, research institutes, and startups prior to starting a new business entity because companies do not know everything. Open, collaborative innovation approaches are considered a better fit for

the requirements of innovation and new product development in the bioeconomy (Van Lancker et al., 2016).

Similarly, these collaborations have greater viability to be marketed when companies partner with startups or form a joint venture that operates as startups. This may be due to factors such as the bureaucracy in large, mature companies, and the flexibility to changes and speed of expansion in startups. Collaboration between large corporations involve a bureaucracy challenge for both parties because of the processes and legal documents that are required. While partnerships with startups is key for fostering innovation in mature companies. It can also benefit both sides, helping mature companies to create new technologies, products, and markets and startups to develop their business ideas and disrupt traditional industries (Näyhä 2019). Forest sector companies may benefit from collaborating with startups to mitigate challenges and risks, create more valuable products and business models, integrate their materials to other industries, and gain skills needed to disrupt the markets (Pelli et al. 2018).

3.4.4.3 Value creation in cross-sector collaborations

Value creation is one of the alignments of interest specified by all executives regarding why companies decided to collaborate (Murphy et al., 2015). Executives in Alpha and Beta reported that forest sector companies were interested in reaching new markets, better utilizing their waste, getting more value, and obtaining financial benefits for producing byproducts from forest-based residues. Whereas energy companies were interested in ensuring their supply of biofuels, defeating the competition, expanding their markets, and avoiding financial penalties. Further,

executives reported that all corporations involved in the cases were aimed to create value from forest-based residues. They described that these collaborations were a great way of improving social value and image, or social acceptability by forest sector companies because they were using forest wastes from thinning and milling processes to turn into renewable fuels.

> And at a management level, I think they saw the opportunity to grow revenues developing a new product stream to supply wood products, or even grow energy crops like switchgrass on their forestland (Energy Industry CEO, North America).

> …we were involved in an alternative to fossil fuels. This was at a time when forestry wasn't viewed really well. It was like you take the two bad people, oil industry and the forest industry and put them together. And we were working on something that people can say well that's cool, you guys are doing that? That's great (Forest Industry Director, North America).

Interviewees in Gamma and Delta expressed that to create new business models and values chains for replacing fossil-based materials and products, access to new markets, and add value to the whole forest supply chain are the main aim of these collaborations. They emphasized that there is a globally increasing demand for bioproducts that companies from different industries want to meet. Forest executives stated that forest sector companies need to develop new technologies and business models to capitalize on the growing demand for renewable materials and reduce the time to market. Otherwise companies outside the sector will fill that void and forest sector companies will only take part as biomass providers (Näyhä and Pesonen 2014). A forest executive described that companies need to have partners who know about these industries and markets to implement the new value chains and get further in their development. The ability of the partners to deliver a two-way value regarding

expertise and innovation was also described as a crucial aspect of these kinds of partnerships.

> We need to somehow be finding those ideas, and organizations who come from outside our sector and be part of or invite them to our network, and then start working on these new products, and, reaching the new market (Forest Industry CEO, Europe).

> …the value of the collaboration was that it would cover the whole value chain. And the other one was that we have a partner who knew about the raw materials part of the value chain. If we have been doing that alone, we would have needed to create our own competence on that (Energy Industry VP, Europe).

All forest executives reported that partnering with companies outside of their sector helps forest sector companies to create new value and specialty materials from wood resources (e.g., microfibrillated cellulose, dissolving pulp for textile, etc.), shift into new products and markets, accelerate time to market, penetrate new businesses without having the competencies, and achieve their core strategy. Forest executives of Gamma illustrated that these collaborations allow companies to optimize the value and get the most from wood fibers. A forest executive described that these initiatives are an easier way to diversify company products because they are taking materials that are available and creating value-added from them. He also claimed that there is a diversity of markets for products coming from these renewable materials.

> …the opportunity to grow is huge because now we're dealing with the US refining capacity effectively. We could be providing 5% of the US oil from wood fiber. That market is huge, and I ain't talking about heating oil yet. But the potential is massive (Forest Industry Director, North America).

These developments require a broader set of skills that are not easy to find in the forest industry (Hansen 2016). Mature forest sector companies can obtain that knowledge through intellectual property rights from collaborations or they can obtain

it licensing startups with the relevant knowledge and technologies (Näyhä 2019; Näyhä and Pesonen 2014).

3.4.5 The role of forest company culture in cross-sector collaborations

All executives emphasized that forest sector companies have a conservative, traditional business culture and no experience collaborating with other industries (Hämäläinen et al., 2011; Näyhä & Pesonen, 2014; Orozco et al., 2013). However, executives in Beta, Gamma, and Delta stated that this culture is changing because of exposure to opportunities, other business areas, technical know-how, and skills for building new technology and businesses. An executive expressed that his company hiring people with different mindsets and skills is part of this cultural change. The executives of these forest sector companies also stated that their companies remain very open to collaborating with firms outside of their sector. They are interested in supporting new technologies that can help them to develop new products, accelerate the time to market, improve the existing customer base, and support the innovation ecosystem globally. Forest industry executives described that these initiatives have opened the doors to new CSCs and changed the culture of their companies.

> One could say that there is not so much CSC. But when we started to look for new products, and new markets, it's evident that you are crossing sectors and start to collaborate with other companies (Forest Industry CEO, Europe).

> We are open to it, but if we don't see it really beneficial to join CSCs. If we would collaborate and we would be a raw material supplier, that's not in our interest. We don't see an oversupply of raw materials that we need to get rid of. We think that it will be more scarce resources on the renewable side as time goes forward (Forest Industry VP, Europe).

This shift in approach toward CSC is not only due to changes in corporate culture but also in strategy. Executives in Beta, Gamma, and Delta reported that the changes and crises that have motivated these collaborations, similarly generated a large shift in corporate strategy to innovation. Executives claimed that their companies began collaborating with other industries to reduce cost and have a stronger balance sheet. Since then, it has become a growth strategy. One of these executives, for example, reported that these collaborations are becoming strategic initiatives that are taken by his company to drive and communicate its transformation. One can say that collaborating with other industries has generated changes in the organizational culture of these forest sector companies in their pursuit to capitalize on the growing bioeconomy.

> We started collaborating for reducing fossil fuels in transportation. We saw it wouldn't be economically feasible. So, we stopped, then we thought that we should transform the company. We shifted [our corporate strategy], we started targeting into renewable products and chemicals (Forest Industry VP, Europe).

> …in the past, we have not been very vocal in the market, in the sense that we don't make too many public announcements. But this has changed because when we do public announcements, we are sending signals to other markets and other players in the bioeconomy. And this even attracts new partners, talent, people, and researchers and universities (Forest Industry Director, Europe).

Research shows that most companies lack proactive strategies for creating the products and business models needed for embracing the bioeconomy (Näyhä 2019; Näyhä and Pesonen 2014; Pelli et al. 2018). Hence, culture is an essential challenge that can facilitate or interfere with their pursuit of collaborating with other industries and capitalizing on the bioeconomy.

3.4.6 Collaborating with competitors in the forest industry

Collaborative competition, or coopetition, emphasizes the simultaneous collaboration and competition between rival-companies or “frenemies" for achieving mutual benefits (Bengtsson et al. 2016; Bengtsson and Kock 2000; Gnyawali and Madhavan 2001; Gnyawali and Park 2011; Klimas 2016). Although coopetition is a relatively new concept in the forest industry (Rusko 2011), most executives mentioned that open coopetition (collaboration among competitors through open innovation (Le Roy and Chesbrough 2018)) was present during the activities in the early development of the collaborations. They said it is a crucial factor that can contribute to the success of these types of partnerships. Interviewees in Delta, for example, described that open coopetition was done during the R&D phase as a way to obtain the ideas and know-how that are outside of the forest industry. In contrast, one of the VPs from Beta pointed out that the collaboration was aimed at creating internal coopetition (collaboration and competition across a company’s business units (Bendig et al. 2018)) inside of the companies. A similar situation was observed in Delta. Intra-firm coopetition may be created in the forest company for raw materials (downstream coopetition), as well as inter-firm coopetition between the joint venture and textile companies competing for customer and market-share of their products (upstream coopetition). However, it was not mentioned by the executives interviewed.

> We were talking to a lot of startups that were looking at the same things. We were interacting into non-disclosure agreements with all of these companies. There were lot of details to manage because we were sharing data with companies that viewed themselves as competitors (Forest Industry VP, North America).

> …we have to look for a partner who knew about the raw material part of the value chain. If we have done that alone, we would have needed

> to create our own competence on that. And more than that, even to start to compete with all the forest [sector] companies for the raw materials (Energy Industry VP, Europe).

CSC has provided these forest sector companies a way of getting closer to competitors through open innovation. Despite some work indicating lack of trust as a factor that prevents seeing competitors as potential partners (Mattila et al. 2016; Näyhä and Pesonen 2014), our findings suggest that forest sector companies opt to partner with their competitors to mitigate competition; bring more actors to new supply chains; and obtain relevant knowledge, different perspectives, and competitive advantages (Gnyawali and Park 2011; Rusko 2011). Alternatively, this strategy opens information, best practices, and business concepts to the competition and can affect the potential to innovate (Bengtsson et al. 2016). But, the possibility of selectively sharing information, protecting proprietary knowledge and integrating more partners to the collaboration processes compensates the downsides. A bioeconomy market for new forest-based products will ensure forest industry sustainability and help customers and brand owners to rely on more than one supplier. Research on collaborative relationships among competitors is needed to explain how the potential advantages of coopetition can be realized by forest sector companies.

3.5 Limitations and future research

The most notable limitation of this study is the small sample size. Although the number of collaboration cases is consistent with other industrial-based studies targeting top executives, a larger sample size would have been desired. Further, we attempted to interview more than one respondent in each company. This approach was successful with seven of the eight companies. None of the executives from the

textile company in Delta were interviewed due to their lack of time. Nevertheless, we interviewed executives representing the perspective of the joint venture and the forest company. Accordingly, this work provides useful information for enhancing our understanding of CSCs in the forest industry but is not aimed to be generalized to any population beyond the study sample.

None of the collaboration cases documented have been marketed yet. This may have limited our analysis and findings because there is no certainty that the ongoing collaborations would be commercialized. Future work should be done to document and analyze the outcomes, challenges, and elements needed for these collaborations to be successful in the market. Future research should address how parent companies manage the technical know-how and information generated in collaborations. We suggest that future research can describe how intellectual property rights are handled and how the patents portfolio generated is applied to other business or endeavors. Findings about these factors will foster company-level, CSC in the forest industry.

3.6 Managerial implications

Existing policies and strategies have emphasized the need for implementing CSCs in the forest industry as a means to transition toward the bioeconomy. As a result, mature forest sector companies have focused on transforming their businesses into bio-innovations by creating new technologies and offering more sustainable products and services. The results of this study show that focusing on new processing technologies, innovations, and business models may be an important strategy to reach new markets, create more value, and remain competitive in the growing bioeconomy.

Companies that were involved in the four collaborations gained new skills and technical know-how for producing bioproducts and a competitive advantage over their competitors. Our results also show that there exists room for improvement in implementing and managing company-level, CSCs in the forest industry. Firms need to learn from past experiences and ensure that future initiatives are based on early R&D projects and simple technological breakthroughs. Managers must keep in mind that CSC is challenging. Accordingly, complex, expensive, and complicated technological processes can maximize the risks. Less complex technologies and business cases tend to generate flexible benefits.

3.7 Conclusion

For forest sector companies, opening up to collaborating with other industries may provide some competitive edges to capitalize on the opportunities presented by the bioeconomy. Companies can acquire new know-how and skills required to support new business concepts, technologies, and products, as well as access new markets. Nevertheless, definition of clear pathways and processes to better integrate the forest sector to other industrial sectors and strengthen the role of these collaborations in the growing bioeconomy is needed. Our proposed model presents similarities with Bryson et al.'s (2015) framework, but it also differs in important ways. Although it reinforces that CSC is a complex phenomenon, it highlights elements such as R&D, innovation, company culture, and coopetition as central components in collaborations involving forest sector companies. Future research should focus on documenting new empirical cases and building a step-by-step

framework for designing, implementing, and managing successful CSCs in the forest sector.

Despite the benefits, CSC remains a major challenge for forest sector companies. Even though companies are shifting in their approach to partnering with corporations from other sectors, the forest industry still has a traditional business culture that neglects collaborations. Further, forest sector companies tend to partner with mature corporations in initiatives with complex, long-term, and capital-intensive technologies, which makes it harder to get these collaborations off the ground. Regardless of these, companies involved in CSC remain interested in partnering with other sectors to integrate the forest industry to the global bioeconomy market. Collaborating with other sectors could be crucial for forest sector companies to achieve the technological breakthrough needed for creating innovations.

Our study does not suggest that every company needs to collaborate with other industries to achieve its goals. The question is, can forest sector companies afford not to collaborate? We believe that even the most traditional companies, regardless of the markets they serve, should strategize about how to develop innovations that create new, more sustainable products and services to remain competitive in the growing bioeconomy. The race for developing new technology to create new forest-based products has started and will continue with or without the participation of forest sector companies. Companies need to implement successful collaborations with neighboring industries for developing innovative business models to join the bioeconomy momentum and avoid being left behind. But success is difficult to reach in CSCs.

Our findings aim to increase the understanding of CSCs involving forest sector companies, but they also shed light on open innovation and coopetition processes that occur in these partnerships. Open innovation processes are done in the early R&D phase of the collaborations with outside organizations, while coopetition relationships are not directly set between joint venture partners but with their partners in business networks and internally in their business units. Although the advantages of collaborating with competitors in open innovation are not clearly defined, this type of interorganizational relationship may become a game-changer for forest sector companies to integrate into other supply chains, share best practices, bring more partners, and facilitate innovation. Forest sector companies open to collaborating with competitor firms from other industries may be better positioned to capitalize on the growing bioeconomy.

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CHAPTER 4. DETERMINING THE COLLABORATIVE POTENTIAL IN OREGON'S FOREST PRODUCTS INDUSTRY: INSIGHTS FROM OWNERS AND CEOs OF MATURE COMPANIES

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Abstract

Cross-sector collaboration has been emphasized in policies and studies as a means for the forest products industry to remain competitive in the global evolution of a bioeconomy. Nevertheless, questions remain regarding how companies can identify and develop new innovations and capitalize on the opportunities presented. What conditions should be present for collaboration? What could be done to achieve successful collaboration? This study addresses these questions by assessing the potential of Oregon's forest sector companies to collaborate with other industries and exploring barriers for implementing collaboration. The Progress Triangle was adapted and used to assess collaborative potential. Results show a high need to collaborate and a moderate to low collaborative potential in Oregon's forest products industry. Training employees on creativity, negotiation skills, and new business models; increasing their exposure to new technologies, products, and markets; and building diverse teams and hiring outsiders may help to improve the collaborative potential in the industry.

4.1 Introduction

In today's globalized market, forest sector companies have started collaborating with other industries to meet consumer and brand owner demand for greener products, reach new markets, and maintain competitiveness in the growing bioeconomy (Bauer et al. 2018; Pelli et al. 2018). Although these collaboration efforts have received considerable attention among academicians and policy makers and are considered important for developing innovation and new biobased products (Wohlfahrt et al. 2019; Bauer et al. 2018; Näyhä 2019; Pelli et al. 2018), limited

research has empirically evaluated the potential of forest sector companies to collaborate outside of the forest sector.

This research seeks to increase understanding of the potential for Oregon-based forest sector companies to collaborate. We use the Progress Triangle, a framework proposed by Daniels and Walker (2001) to evaluate the interrelationships among three dimensions: substance, relationship, and procedure, and to identify weaknesses, issues, and barriers for implementing collaborations. We chose forest sector companies based in Oregon (US) because previous research found that these firms lack collaboration, even between companies in their sector (Orozco et al. 2013). Further, forest sector companies are perceived to be culturally conservative, traditional, and resistant to change (Nybakk et al. 2015; Hämäläinen et al. 2011; Näyhä 2019). In this context, we asked the following research question: What is the potential to collaborate among Oregon's forest sector companies in transition to a bioeconomy? Information from this study can be used by managers to address barriers, foster collaborations, and increase their company's collaborative potential.

4.2 Research context

Company-level collaboration is not a new concept in the forest sector literature (Alayet et al. 2018; Orozco et al. 2013; Mattila et al. 2016; Lehoux et al. 2016; Audy et al. 2012), however, there is a growing interest among forest sector companies in implementing novel partnerships across neighboring industries such as textiles, energy, chemicals, or plastics for replacing fossil-based products with renewable materials in transition to the bioeconomy (Näyhä 2019; Pelli et al. 2018; Bauer et al. 2018; Wohlfahrt et al. 2019). To date, the issue of collaborative potential

has been only addressed internally in the forest products industry (Lehoux et al. 2016; Alayet et al. 2018).

Collaborative potential is defined as the ability of parties, stakeholders, or organizations to work together to achieve a common goal or obtain meaningful progress in the management of controversial and complex situations (Walker et al. 2015; Daniels and Walker 2001). This can be perceived based on two factors. First, a high need for collaboration is determined because new opportunities are presented for the parties. Second, it is possible to achieve a mutual benefit and integrative outcome or take advantage of opportunities for both or all parties involved (Walker et al. 2015; Walker and Daniels 2019; 2005).

Collaboration opportunities include concepts such as interdependence, open communication, dialogue, trust, learning, power-sharing, negotiation, decision space, benefits, and challenges between parties (Daniels and Walker 2001; Gray 1989, 2000; Wondolleck and Yaffee 2000). Because collaboration requires sharing sensitive information and the investment of resources, benefits can be met and capitalized only when companies are willing to build trust and allocate enough financial and intangible resources (Alayet et al. 2018; Näyhä and Pesonen 2014; Lehoux et al. 2016; Lehoux et al. 2014). Research has described many benefits of implementing company-level collaboration in the forest products industry. These include aspects such as reducing and sharing costs (Lehoux et al. 2014; Frisk et al. 2010; Audy et al. 2012); implementing sustainable practices and reducing environmental impact of operations (Näyhä and Pesonen 2014; Hämäläinen et al. 2011); learning new knowledge and skills, and increasing savings and profit-sharing (Audy et al. 2012;

Lehoux et al. 2014). Nevertheless, companies should take the time to develop and manage collaborative benefits carefully to avoid risks and unexpected changes (Lehoux et al. 2016).

Assessing the collaborative potential in an innovative approach or decision situation helps to determine: 1) if collaboration is feasible, and 2) what areas need to be addressed to increase the potential to collaborate and the possibility to reach good outcomes (Walker et al. 2015; Walker and Daniels 2005). A critical factor of assessing collaborative potential is decision space (who are the authorities that make the decisions). Power sharing, decision authority, and participatory access are indicators of decision space. The greater the decision space, the greater collaborative potential. It should be addressed during the assessment of a decision situation (Walker et al. 2015; Walker et al. 2006). When an assessment is conducted, researchers must start by determining the perceived need for collaboration. If there is a low need for collaboration, collaborative potential does not need to be assessed. If there is a high need for collaboration while the collaborative potential is low, the researcher should work with the parties and stakeholders to identify ways for improving the collaborative potential (Walker et al 2015; Walker and Daniels 2019).

Few studies have been conducted to evaluate the potential to collaborate in forest sector companies (Lehoux et al. 2016; Alayet et al. 2018). Studies have focused on approaches that involve managing relationships in inter-firm collaborations aimed at improving the supply, manufacturing, and delivery of forest products along the supply chain (Lehoux et al. 2016). In a study conducted on transportation of wood products, a centralized approach for collaborative planning was proposed to evaluate

the potential of eight companies to collaborate with Swedish forest transportation authorities to increase savings (Frisk et al., 2010). A logistics scenario was also proposed to test the potential collaboration for cost-sharing and delivery time reduction in transportation among four furniture manufacturers in Canada (Audy et al. 2011). Currently, these collaborations are no longer in operation because they were based on assessing potential cost-saving benefits and were not fully implemented (Basso, D'Amours, Rönnqvist, & Weintraub, 2019). Research work has also focused on the potential of forest sector companies to partner with energy, chemical, and technology companies, among others, but these are mostly theoretical recommendations (Näyhä and Pesonen 2014; Näyhä 2019; Hämäläinen et al, 2011).

In this study, we apply the techniques of The Collaborative Learning Approach (Daniels and Walker 2001). To guide the collaborative potential assessments, we used the Progress Triangle. A model framework based on the assumption that improvements in the management of complex decision situations can be achieved by continuously improving three interrelated dimensions: substance, procedure, and relationship. The Progress Triangle is used to examine the tradeoffs and obtains a "snapshot" of the potential to collaborate by identifying the decision space or procedure, degree of trust between parties involved, and the available technical and traditional information sources or substance (Daniels and Walker 2001; Walker et al. 2015). Collaborative potential can be assessed using different frameworks, such as the Unifying Negotiation Framework (Daniels et al. 2012), Collaborative Alignment (Walker and Daniels 2019), and the conflict map (Bartos & Wehr, 2002). However, we found the Progress Triangle framework to be more

appropriate for our study's objective because it can provide a preliminary assessment before starting a decision situation or collaboration. Further, it works well for building and addressing possibilities to agree in negotiation (Walker et al. 2015).

The Progress Triangle has been applied by researchers for addressing and managing environmental and natural resources conflicts and decision situations in several contexts, including national park-community relationships (Lee et al. 2018), forest management (Dubois and Lowore 2000; Nevenic et al. 2011; Raitio 2016), forest planning (Walker et al. 2008), and the forestry and wood processing industry (Marić et al. 2012). Most of these studies use this model to characterize the framework's dimensions and manage the antagonism involved in collaborations in order to assess the synergy, tensions, and collaborative potential among various stakeholders. Research work regarding the potential of the forest products industry to collaborate with neighboring sectors for developing innovative forest-based products may gain the attention of forest industry managers.

4.3 Methods

We conducted personal interviews with owners and CEOs of large forest sector companies based in Oregon to assess the potential to collaborate with neighboring sectors, as well as explore pathways and barriers to implementing collaboration. We evaluated the company's collaborative potential using an adaptation of the Progress Triangle framework (Walker et al. 2015; Walker and Daniels 2005). We adapted this framework because it is employed in the management of complex, controversial, and uncertain challenges, as well as decision-making situations in natural resources by incorporating techniques of the Collaborative

Learning Approach (Daniels and Walker 2001). It is a theory-based approach built to help organizations to collaboratively manage environmental conflicts or decision situations (Daniels and Walker 2012; Conley and Moote 2003; Walker et al. 2006).

Participants were identified from a list of 25 companies, representing privately-owned wood products manufacturers in Oregon. The list was built via recommendations provided by experts from OSU and the Oregon Forest Industries Council (OFIC) following a snowball sampling procedure (Babbie 2012). Potential interviewees were contacted by email, followed by a second email or telephone call. In total, we interviewed owners and/or CEOs from 15 companies, stopping once we reached data saturation (Miles et al. 2014). Saturation was reached after the first twelve interviews, but three additional owners/CEOs were interviewed to fully confirm data saturation (Galvin 2015; Guest et al. 2006). All but one participating company was a family-owned business. Nine companies had owners or family members as CEOs, while six had individuals who are non-family members as CEOs.

4.3.1 Data collection

Semi-structured interviews were used to collect data in this study to engage participants in a neutral manner while also allowing for follow up questions (Babbie 2012). An interview protocol was created using findings from a multi-case study on cross-sector collaborations (Guerrero and Hansen, in preparation) and, existing literature on Collaborative Learning and the Progress Triangle framework (Corrigan et al. 2015; Daniels and Walker 2001; Walker et al. 2015) (Appendix C). The interview protocol was reviewed by researchers at OSU. Minor changes were made after the reviews. Most interviews were conducted face-to-face, two were conducted

by phone, from June to August 2019. Interviews lasted from 30 to 68 minutes. All interviews were audio-recorded, transcribed, and coded. Transcripts were reviewed by a second person before analysis to ensure accuracy (Patton 2002). Data were analyzed after each interview to better focus the interview strategy according to the emerging data and to enrich the data collection and analysis process (Maxwell, 2009). Secondary data derived from company websites, press releases, and literature sources were employed to complement interview information (Miles et al. 2014).

4.3.2 Data analysis

Data were analyzed following a three-step analysis approach as suggested by Miles et al. (2014): data reduction, data display, and data verification or conclusions. In the first step (data reduction or coding), transcripts were read and coded by the first author using the software NVivo 12. Coding analysis was conducted in three cycles (Miles et al. 2014). The first cycle was focused on three themes (willingness to collaborate, benefits, and organizational environment) related to our research question. During this cycle, 21 codes were created. The second cycle was subsequently conducted to find patterns by categorizing the earlier codes from the first cycle to a smaller number of themes to facilitate interpretation. When a new code was identified, it was added to the analysis. The third cycle was conducted combining the first and second cycle approaches. Ultimately, data were reviewed and grouped into six identified themes. The identified themes were categorized in the three dimensions presented in the Progress Triangle framework (Table 4.1).

Table 4.1. Themes and subthemes identified in the analysis organized by dimensions

Framework's dimensions	Primary themes	Subthemes
Relationship	1.Willingness to collaborate	1.Company culture 2.Company goals 3.Corporate strategy 4.Sectors to collaborate 5.Stakeholders/decision authorities 6.Willingness to collaborate
	2.Actual and potential benefits	1.Benefits 2.Coopetition 3.Incentives to collaborate
	3.Changes and needs	1.Changes 2.Needs 3.Training 4.Trust (Trust building)
Procedure	4.Capacity to collaborate	1.Capacity to collaborate (strengths) 2.Company assets
	5.Alternatives to collaboration	1.Alternatives to collaboration
Substance	6.Issues, challenges, and barriers	1.Company concerns 2.Legal constraints (Policy and legal frameworks) 3.Issues (Challenges and barriers) 4.Tensions and conflicts 5.Weaknesses

To assess coding reliability, an undergraduate student was trained by the first author on coding with NVivo 12, including an explanation of the study and the coding scheme (Campbell et al., 2013). Two interview transcripts were selected at random and coded by the student in NVivo 12. The student worked on an individual basis and without discussing the coding process with the first author. Intercoder reliability was calculated with a Kappa value of 0.65. We compared results and discussed differences in coding judgments, but found no need to modify the coding

scheme (Campbell et al. 2013). Finally, a Kappa value of 0.86 was achieved, indicating excellent reliability (Miles et al. 2014). After this stage, the first coding cycle was reviewed and verified.

In the second step, data were summarized and displayed in matrices with rows representing interviewees and columns containing information addressing the questions. We used the Progress Triangle framework for organizing questions and responses according to the three dimensions (Appendix D and E). Themes representing the interviewee's responses were organized into a large matrix to describe the company's contexts and perspectives in each dimension (Lee et al. 2018; Walker and Daniels 2005). In the third step, we employed a modified version of the Collaborative Potential Screening Worksheet (which is a screening tool used to identify decisions situations) and conducted a subjective situational assessment to determine the perceived need to collaborate, connections among dimensions, and collaborative potential in Oregon's forest products industry (Appendix F) (See Walker and Daniels 2005). We determined the need for collaboration by describing the company's context and their willingness to collaborate (steps one and two). To determine collaborative potential, we used the interview findings (interviewee's responses and perspectives regarding potential collaboration) and rated them using a list of fifteen items based on the framework's dimensions to obtain a score (step three). The greater the score, the lower the collaborative potential and vice versa (Walker and Daniels 2005). Then, we identified issues and highlighted situations that should be addressed to improve dimensions and increase a company's collaborative

potential (Daniels and Walker 2001; Walker et al. 2015). Finally, conclusions were drawn and verified with secondary data sources to ensure their validity.

4.4 Results and discussion

Table 4.2 provides a summary of the findings from the interviews. Findings and themes are organized into the framework's dimensions to better understand the company's context and their perspective and provide recommendations to improve the potential for collaboration. This section introduces the Progress Triangle framework and its dimensions (Figure 4.1). Willingness to collaborate, benefits, and changes and needs emerged as central relationship concepts. The procedural dimension focuses on the capacity for and alternatives to collaboration while the substantive addresses the issues, challenges, and barriers. Our findings build on Daniels and Walker's research by applying their framework to determine collaborative potential among forest sector companies. All quotations in the text below come directly from the interview transcripts.

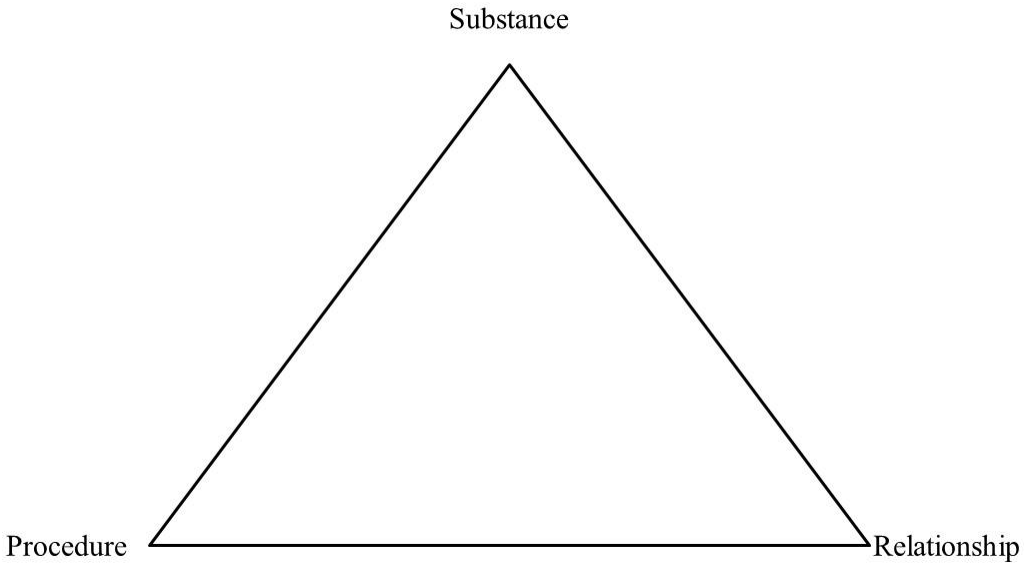

Figure 4.1. Progress Triangle (Daniels and Walker 2001).

Table 4.2. Benefits, challenges and issues associated with implementing company-level, cross-sector collaborations (CSCs).

Companies interested in CSCs	Progress Triangle framework's dimensions				
	Relationship		Procedure		Substance
	Benefits	Changes and needs	Capacity to collaborate	Alternatives to collaboration	Issues, challenges, and barriers
1	• Not interested in CSCs	• Generational change		• In-house development / diversification	• Traditional family attachment & paternalism
2	• Be ahead of competitors	• Trust building/expertise	• Trustful/experience	• In-house development	• Lack of knowledge & expertise
3	• Access to new markets	• Trust building/expertise	• Trustful/our people (team)	• In-house/acquisitions	• Lack of knowledge & expertise
4	• Be ahead of competitors	• Trust building/expertise	• Trustful/experience/people	• In-house/acquisitions	• Lack of knowledge & expertise
5	• Problem solving	• Generational change	•	• In-house/diversification	• Conservative & traditional
6	• Be ahead of competitors	• Trust building/expertise	• Trustful/experience/people	• In-house/acquisitions	• Heavy investment required
7	• Be ahead of competitors	• Trust building/expertise	• Trustful/experience/people	• In-house/acquisitions	• Heavy investment required
8	• Not interested in CSCs	• Trust building/expertise	• Trustful/experience/people	• In-house	• Lack of knowledge & expertise
9	• Not interested in CSCs	• Trust building/expertise		• In-house	• Volatile & unstable market
10	• Not interested in CSCs	• Trust building/expertise		• In-house	• Resistance/struggle to innovate
11	• New skills & knowledge	• Trust building/expertise	• Trustful/experience/people	• In-house	• Resistance/struggle to innovate
12	• New skills & knowledge	• Trust building/expertise	• Trustful/experience	• In-house	• Volatile & unstable market
13	• Be ahead of competitors	• Trust building/culture	• Trustful/experience/people	• In-house	• Companies are too small
14	• Stay ahead of competitors	• Generational change	• Trustful/experience	• In-house/acquisitions	• Companies are too small
15	• Stay ahead of competitors	• Trust building/expertise	• Trustful/experience	• In-house/acquisitions	• Heavy investment required

4.4.1 Willingness to collaborate

Most interviewees expressed that their companies are involved in several collaborations inside the forest products industry. Interviewees mentioned collaboration occurring with customers, vendors, forestland owners, government agencies and other forest sector companies, even competitors. However, only four respondents stated that they are currently collaborating with firms from other industries. These collaborations include initiatives for diversifying their company's portfolio and developing new forest-based products (e.g., biocrude and aviation biofuel) and remain in the research and development or demonstration phase. Furthermore, most interviewees highlighted that their companies are highly interested and open-minded toward partnering with firms from neighboring industries, including energy, plastics, technology, construction, nanotechnology, chemistry, aviation, automotive, among others.

> We are involved in collaboration inside and outside. It's slow to develop, always harder than heck to get these things off the ground. But we have taken a lot of risk. We are not in a hold and harvest mode, like a lot of companies. They are so big, they are family hold [held], or whatever they are, and nobody wants to lose money. So, they kind of just do what they do.

> We are working in some collaborations that are in R&D with energy and nanotechnology companies. We are trying to stay one step ahead of our direct competition.

Those companies that were not interested in collaborating with other industries expressed several reasons. Some interviewees stated that although their companies are aware of the new opportunities for forest resources, they do not want to get distracted because there is a big room for improvement in their core business. Interviewees described their companies as small businesses that lack expertise and

resources, do not like to have debts or take risks, and are too conservative to partner with other industries. Respondents also emphasized an existing traditional family attachment and paternal culture in this industry. One respondent claimed that his company was not interested in collaborating either inside or outside the industry because they have always done and want to continue doing everything independently.

> I don't think that we are looking for that kind of collaboration. We are a family-owned company. We do not have enough to offer to anybody else to be interested in working with us. So, we're not a large multi-location company.
>
> We are participating in a collaboration to produce biofuel, but we are not an owner in that, we will be a supplier of raw material. We are not interested in ownership.
>
> I hate these words, but unfortunately, from the family's perspective, this is what they have always done. So, there is a huge emotional attachment to this business.
>
> This company has a strong loyalty to the employees. When I am tossing out ideas with the family about strategic decisions such as selling off one portion of the company, the owners always say, it'd be a hell of a thing to do to our employees.

A connection between the company's CEOs and their willingness to collaborate was identified. Almost all companies having non-family members as CEOs were more interested in partnering with other industries than those having family members as CEOs. Further, companies run by younger managers were also more willing to collaborate with outside firms. Our results show companies with a positive attitude toward collaboration which is dissimilar to previous findings (Hämäläinen et al. 2011; Mattila et al. 2016; Näyhä 2019). However, it seems unlikely that family-held firms would change their way of doing business. Traditional

family attachment and paternalism in businesses may be part of the reasons why the forest products industry is culturally conservative and traditional.

4.4.2 Actual and potential benefits of cross-sector collaboration

Some interviewees stated that partnering with outside industries has provided companies opportunities for gaining new knowledge and the expertise required to develop novel innovations and new forest-based products as a way to enhance profitability. Interviewees also claimed that collaborating with outside partners has allowed companies to integrate complementary skills, knowledge, and expertise in new areas. Sharing resources between partners such as facilities and employees was also highlighted by interviewees as an important benefit. Reducing costs, increasing savings and profit-sharing, improving innovation, identifying new business opportunities, and staying ahead of competitors were the main incentives emphasized by interviewees to collaborate with outside firms. One respondent, for example, reported that saving and reducing costs is one of the reasons why his company is partnering in projects with outside partners.

> Well, certainly expertise and areas that we don't have. When I look back to what we have done, I think that bringing in that outside expertise helped us to make the project what it is today. Because we don't know everything. We know that we're not going to develop everything internally.

> Our company always have been driven on innovation, technology, and so forth. So, we're trying to stay one step ahead of our direct competition. For us, the next logical step in a normal progression would be, how do we add value to what we do today? I think that is something we need to explore. But I want to be one step beyond what other companies are doing.

Potential benefits for forest sector companies of collaborating with neighboring industries have been emphasized in several studies (Näyhä 2019;

Wohlfahrt et al. 2019; Pelli et al. 2018; Bauer et al. 2018). Our results show that forest sector companies collaborate outside of their sector to achieve new goals, develop new ideas, solve problems, gain joint benefits, and create value for forest resources (Howard et al. 2016; Pelli et al. 2018). Identifying and describing benefits associated with this kind of partnership may highlight the potential value and encourage forest products industry managers to seek outside partners to work in new business models.

4.4.3 Changes and needs

Myriad changes and needs were described by interviewees. A generational change in the leadership roles of the companies and implementing ad campaigns to encourage the consumption of wood and forest-based products were described as changes needed to make collaboration across sectors more attractive for forest sector companies.

> We are a very conservative company. And companies go from generation to generation, this generation is pretty conservative, and not as entrepreneurial as some others. I suspect it will take a generational change for us to collaborate outside the industry.

Building trust was emphasized by all interviewees as an ongoing requirement for successful collaboration. Interviewees described that knowing the history and leaders of companies is essential before starting a partnership. Some interviewees claimed that hiring new employees with negotiation abilities, knowledge, expertise, technical skills required in the new business models would be needed for companies to be effective collaborators. Interviewees also mentioned that to have consistent policies and regulatory support and create educational initiatives for consumers

focused on alternative uses of wood as a renewable material would make companies more attractive for outside potential partners.

> I just don't think there's enough trust for it [cross sector collaboration] to happen unless the marketplace dictates it.
>
> Trust that's built up over time. You have to have trust, integrity, competence, and performance that show that you are valuable and have something to offer.

Nevertheless, some respondents highlighted that collaboration cannot be done without financial resources and support from the owners and board of directors. The company's CEOs, the board of directors and owners act as the decision-making authority. Because of the decision leadership authorities described above, forest sector companies have an appropriate and clearly defined decision space to collaborate outside of the industry (Walker et al. 2015; Walker and Daniels 2005; Walker et al. 2006).

Trust-building was frequently claimed by the interviewees as an important change needed to collaborate with other industry. Because there is an individualistic orientation and traditional business culture in the forests products industry, the importance of establishing and maintaining trust among partners has also been highlighted in several studies in the forest sector literature (Mattila et al. 2016; Näyhä and Pesonen 2014; Zander et al. 2016). We suggest that building trust with customers would also be needed for these collaborations to improve processes and ensure that the new products can be marketed. The closer companies get to commercializing a new product, the more they will need help from and collaboration with their customers.

4.4.4 Capacity to collaborate

Almost all interviewees agreed that the trustworthiness and reputation of their companies are the best strengths they have to partner with other industries. Some interviewees claimed that having a good reputation has many benefits for collaboration. Most interviews also highlighted that the long-term expertise and knowledge of their companies, as well as the experience, competences, and technical skills of their employees, are the best potential they have for being attractive collaborators. Interviewees mentioned that the experienced executive team and upper management are important strengths for their companies to collaborate. However, one respondent emphasized that although his company is not interested in collaborating outside of the industry, they have several assets, including certified timberlands, sustainability ethic, and knowledge and expertise, that can make them an attractive collaborator.

> It really takes three things for collaborators. One, you have to have the trust and people will have to have a reason to collaborate, then you have to have dedicated resources. And then you need money.

> Well, I'd say a pretty solid balance sheet. We've got some size; we got a lot of geographic reaches. And I think we've got receptive people. And we've got the thinkers, which, that's an important part. People dynamic, their openness and willingness to explore are what we offer. And that is an important aspect that we continue to reinforce and develop. And that's based on how we hire

Partnering with firms from outside the industry provides myriad potential benefits to forest sector companies. Nevertheless, forest sector companies have some unique assets and resources and competencies that are valuable and difficult to imitate for firms from other industries (Näyhä 2019). Intangible resources and competencies such as expertise and knowledge in the use of forest resources are needed for outside

companies to fill resources gaps in the creation of new forest-based products in the transition to a bioeconomy (Näyhä and Pesonen 2014; Bauer et al. 2018). Success in the development of these new forest-based products may not be easy without collaborating with forest sector companies.

4.4.5 Alternatives to cross-sector collaboration

In-house development was indicated by all interviewees as the main approach employed by their companies to pursue corporate goals. Some interviewees described that their companies have an organic or internal technological development process that is one of the pillars from which they get ideas and develop innovations. However, interviewees mentioned that these in-house developments also need collaboration with several actors, including universities, startups, forest sector companies, and even with their competitors. Mergers & acquisitions were also reported by most interviewees as a method for achieving the company's goals.

> Collaboration is a challenge for us. When we try to create something, we usually just to do it on our own and we want to keep doing everything on our own.

> Since I came into the chair, we were already working on some things internally, but we've made some acquisitions. We've purchased a lot of timberlands; we're building a new facility.

Even though not every forest sector company needs to collaborate with inside or outside firms to develop new forest-based products or achieve their corporate goals, collaboration with different actors in the forest products industry may be needed more than ever to address the evolving need to replace fossil-based materials with forest-based resources (Alexiev et al. 2016). Because the operational environment of the industry is becoming more complex and it is increasingly

challenging to maintain long-term competitiveness (Korhonen et al. 2018), even the most conservative and traditional companies should start thinking of collaboration as a means to facilitate innovation and solve problems.

4.4.6 Issues, challenges, and barriers

The conservative and traditional business culture was stated by almost all interviewees as the most important issue and barrier faced by their companies to collaborate. Some interviewees reported that some forest sector companies are very conservative and less entrepreneurial than their founders and previous generations. One respondent claimed that this culture was even similar across companies, both publicly and privately held. The lack of knowledge, expertise and qualified personnel, as well as the financial resources required were also described as a challenge by most interviewees. Interviewees pointed out that one of the biggest reasons why their companies are not involved in collaborations is because the investment is very large.

> I have seen some companies that when they do things, they like to go big. [They] build state-of-the-art facility, best of the best equipment, everything's brand new. We keep things up. We keep things running. But we're not like that, we are more of an old farmer school mentality. We try to find the stuff that works.

> Companies are so internally focused that they don't look around, they don't have exposure to the broader industry, the technology and processes and markets. And so, in that regard, we need to really invest in the facilities to modernize them.

Most respondents stated that the volatility and instability of the forest products industry and market is a big challenge for their companies. Respondents reported that because most forest products are commodities, business and markets are very volatile. One respondent mentioned that this volatile market is one of the reasons why his company is collaborating outside. They are trying to create more stability and reduce

dependence on commodities. Despite the volatile and unstable market, some interviewees claimed that fear of losing independence, failing, and the struggle in developing innovations are barriers to collaboration.

> … there [in collaboration] might be the opportunity to provide something with a less volatile earnings posture. Because you're well aware, the industry is very volatile, is based on pricing and revenue.
>
> I think our industry struggles with innovation. And rarely, they are willing to invest the time and the capital resources to go develop something new. I can remember, years ago, the commentary was, well, it's better to be second, not first. Let the first guy go and develop it. And then we'll be a fast second behind them.

The conservative and traditional culture of forest sector companies, which is resistant to changes and neglects collaboration, has been described in several studies (Hämäläinen et al. 2011; Näyhä 2019; Orozco et al. 2013; Nybakk et al. 2015). In the forest products industry, challenges related to the conservative business culture and the lack of expertise and qualified personnel may affect the potential of individual companies to collaborate with neighboring sector industries. Organizational initiatives such as involving more younger family members, hiring younger and open-minded employees in leadership roles, increasing employee exposure to new technologies, markets, business cases, and models, and building diverse and interdisciplinary teams would be the most direct ways to start shifting the industry culture and increase its collaborative potential (Orozco et al. 2013). Company culture is still a limitation to successfully collaborate outside in the forest products industry.

4.4.7 Collaborative potential assessments

Our findings from the situational assessment discussed above suggest that there is a high perceived need to collaborate with outside firms in Oregon’s forest

products industry. This perceived need to collaborate is based in (1) the new opportunities for forest resources presented outside of the industry, (2) the volatile and unstable industry and market for the forest products commodities and the interest of companies to reduce dependence on commodity products, (3) the high interest of forest sector companies to collaborate with other industries. Results from the subjective situational assessments show a score of 51 points (Appendix F) which is considered as a moderate to low collaborative potential (Walker et al 2015; Walker and Daniels 2005).

Several of the recommendations described and discussed above can help to increase the collaborative potential in Oregon's forest products industry. Nevertheless, we want to emphasize that most of these recommendations are focused on improving the substantive dimension because it registered a higher score among the three dimensions. Although it is beyond our research, we suggest that creating and implementing an educational program by partner companies to promote the potential new products can increase collaborative potential and consumption of forest-based resources. An educational program may help to create marketing strategies and communication initiatives to pull consumer interest towards the new products and make the market foster cross-sector collaborations involving the forest sector companies.

4.5 Limitations and future research

There are some limitations associated with our research, the most notable being that our sample is based in forest sector companies from a single state in a single country. A second limitation of this research is that we assess collaborative

potential across sectors using only information from companies and decision authorities within a single industry (the forest products industry). Even though it is needed to have at least two parties to determine their potential to collaborate, assessing collaborative potential by interviewing forest industry managers also provides useful information because decision space is clearly defined among the companies. Nevertheless, future research should verify the findings and conclusions of this work with forest sector companies in other US states and countries and other manufacturing industries. Finally, the need and potential to collaborate were determined using the Collaborative Potential Screening Worksheet by a subjective situational assessment, which allows for the introduction of researcher biases. We verified our conclusions using secondary data sources to ensure their validity. Future research work should assess the potential to collaborate in the forest products industry using the worksheet working directly with managers.

4.6 Management and policy implications

This research will help policy makers and forest products industry managers to address issues, weaknesses, and barriers that limit the ability of forest sector companies to partner with firms from other sectors and improve their collaborative potential to capitalize on the increasing demand for new, greener products. Given that there is a high perceived need for collaborating across sectors and a moderate collaborative potential among Oregon's forest sector companies, managers may benefit from research that provides knowledge-driven recommendations for improving company collaborative potential. Initiatives that increase employee exposure to new technologies, markets, business cases, and models, as well as

education of consumers about alternative uses of wood as a renewable material (e.g., dissolving pulp for manufacturing textiles, producing biochemicals for replacing fossils fuels in plastics, etc.) are needed to improve collaborative potential. Challenges related to the conservative business culture and the lack of expertise and qualified personnel must be solved. Research on this topic may be especially important to mature forest sector companies since they may need to shift focus in order to maintain long-term competitiveness.

4.7 Conclusion

Collaborating with neighboring industries is gaining importance as a way for forest sector companies to identify and develop new innovations and capitalize on the opportunities presented outside of the industry. However, collaborating outside the industry is a challenging process for companies. Collaboration is a very wide term in the forest products industry, and it means different things to different managers and companies. Collaboration needs, benefits, and challenges are also perceived differently. This is partly explained because of the differences around company culture, goals and strategies. Our study sheds light on the potential of Oregon's forest sector companies to collaborate with neighboring industries. The views of the company's owners and/or CEOs demonstrate that there is a high need for collaboration for developing new business in Oregon's forest products industry. Some conditions should be presented among companies to increase their prospects for potential collaborations. These conditions include (1) willingness to collaborate; (2) incentives and potential benefits clearly defined, (3) trust-building, (4) employees with technical skills, knowledge, and expertise; (5) investments and resources to

create new business models; and (6) a company culture focused on innovation, collaboration and entrepreneurship.

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CHAPTER 5. GENERAL CONCLUSIONS

Cross-sector collaboration has become a modern business buzzword in discussions and forums around the forest-based bioeconomy. Although company-level, cross-sector collaboration is considered complex and challenging and there are many drawbacks, it may be needed more than ever in the forest industry. Successful cross-sector collaborations by forest sector companies with neighboring industries can be an important management tool for companies to obtain long-term advantages and remain competitive amidst the profound changes taking place in globalized markets. As the demand for new forest-based products becomes increasingly global and spread across industries, collaboration with outside firms is seen as a key to increase innovation and competitiveness in the forest sector. However, we should first understand the challenges and barriers faced by forest sector companies collaborating with outside industries.

The purpose of conducting this dissertation was to enhance the understanding of cross-sector collaborations between forest and neighboring sector companies and explore the potential for forest sector companies to collaborate with other industries. To meet this aim, company-level, cross-sector collaboration in the forest industry was investigated following a three-phase qualitative research design. In the first phase, the review shows that the literature on cross-sector collaboration specific to forest sector companies is scarce. Even though the literature has emphasized its importance, little empirical work has been done regarding the link between forest sector companies and other industrial sectors. Hence, collaboration across sectors remains a major challenge for the forest industry.

In the second phase, two past collaborations and two ongoing were profiled to compare factors, mechanisms, and conditions for gaining insights into how cross-sector collaborations may be more likely to succeed. The comparative analysis highlights that similarities were more evident than the differences among the four collaborations. Results showed that elements such as open innovation networks, less complex technological developments, collaborative company culture, and a coopetitive environment (where companies cooperate and compete at the same time) were present among the conditions that favor the likelihood of success. The multi-case study did a good job of identifying and describing initial conditions, outcomes, issues, barriers, and challenges involved in the collaborations. However, because the collaborations documented have not been marketed yet, it is difficult to generalize if these findings can be used by forest sector managers to successfully design, implement, and manage cross-sector collaborations.

The potential conditions and barriers that are presented in the forest products industry to collaborate successfully with other sectors were assessed through a situational assessment. In the third phase, owners and CEOs of Oregon's forest sector companies were interviewed to better understand when a collaborative effort can be appropriated and what could be done to achieve a successful collaboration. Results highlighted that new opportunities for forest resources presented outside the industry, volatile and unstable markets, and the interest of companies to reduce dependence on commodity products provide a compelling need for collaboration. However, challenges related to the conservative business culture and the lack of expertise and

qualified personnel among companies must be solved to establish good potential for collaboration.

In the three phases of this dissertation, results contributed to increasing the understanding of company-level, cross-sector collaboration in the forest industry. Findings were consistent with previous industrial-based studies, however, they also contributed to several streams of literature. First, in the field of interorganizational relationships by analyzing and describing novel relational activities between large multinational corporations and providing recommendations to address issues, challenges, and barriers. Second, it contributes to the collaboration literature by using an established framework to document the factors and mechanisms present in company-level, cross-sector collaborations between unlike industries and increase the understanding of their motives to collaborate. It also applies a theory-based framework to determine collaborative potential among forest sector companies and provide some conditions that should be present in the companies to increase their prospects for potential collaborations. Third, this research contributes to the bioeconomy literature by using empirical data to explain the processes by which forest sector companies collaborate with other industries for developing new, greener products. This work provides useful information on cross-sector collaboration but is only an initial step to enhance our understanding of the phenomenon.

5.1 Managerial implications

Forest sector companies have been described as possessing a conservative and traditional business culture that is resistant to change. In addition, companies tend to have an individualistic orientation built on competition where collaboration is neglected. The individualistic orientation of forest sector companies, the conservative and traditional culture, and lack of trust in potential partners limit the development of new business models, innovations, value creation, and competitiveness. The results of this study suggest that collaborating with firms from outside sectors may help forest sector companies to create new-to-the-world products and technologies, increase innovations, and stay ahead of their competitors amidst the profound structural changes taking place globally. Nevertheless, forest sector managers should keep in mind that to develop innovative products and have a collaborative culture, companies must be coherent and consistent with their strategic orientation. Accordingly, a shift in corporate approach to innovation, and in company culture and strategy may be required to successfully collaborate outside the forest industry.

Although findings indicated that company-level, cross-sector collaboration is considered complex and challenging and there are many drawbacks associated with collaboration, forest sector companies involved in these collaborations remain interested in partnering with other sectors. However, forest sector managers must ensure that lessons from the collaborations are learned, and past mistakes are not repeated. Researchers and practitioners should work together to identify and develop less complex and cheaper technologies and business models. These developments

may reduce challenges and risks, capture the attention of environmentally oriented customers, and foster cross-sector collaboration in the forest industry.

For forest sector companies that are involved or interested in collaborating across sectors, managers should encourage an organizational culture that promotes constant learning about joint venture development, build collaboration agreements, management, creativity, and negotiation skills. For instance, because a joint venture was selected as the predominant business model by parent corporations in the documented collaborations, employees leading these initiatives should learn about case examples of implementing joint ventures in different industries. Learning about success and failures in previous joint venture development will allow forest sector companies to evaluate pros and cons and may provide ideas to avoid past mistakes.

There is no specific guideline to follow for forest sector companies seeking to collaborate with firms from other industries. Rather, forest sector managers must identify and select potential partners considering different approaches, including pre-existing relationships among employees or companies, shared corporate strategies and goals, among others. This work offers managers a new way of assessing the collaborative potential of their companies to capitalize on the business opportunities present outside the industry. It outlines six general conditions or prerequisites that must be present among parties or partners involved to increase their potential for successful collaboration. It also provides a modified, preliminary screening worksheet based on the Progress Triangle framework, which can illustrate features on specific situations that may limit collaborative potential

5.2 Limitations and future research

There are several limitations of this research, most of which are mentioned in the individual chapters above. Overall, the major limitation of this work can be related to sample selection, none of the companies that took part in the empirical research were randomly selected. Target individuals and companies were chosen based on their willingness to participate.

Most of the documented collaborations were focused on using forest-based resources to produce biofuels (Chapter 2). These collaborations involve mainly mature companies which are very bureaucratic. Future research should verify the findings of this study in endeavors aimed at developing other forest-based products or services, and ventures involving startups developing new technologies. Additionally, we suggest that future research could be developed for exploring collaborations between startups and mature forest sector companies. Research could document and describe the main outcomes, challenges, business models, products, and markets targeted, as well as factors and mechanisms needed to reach successful partnerships.

Collaborative potential in Oregon's forest products industry was assessed among only regionally large, mature forest sector companies (Chapter 3). This sampling approach may lead to bias regarding the real perceived need and potential to collaborate. Future research work should be done to verify the findings from this study in a wider range of forest sector companies, including various size companies from different wood products manufacturing subsectors. Further, because the Progress Triangle offers a preliminary situational assessment and a snapshot of collaborative potential, future research work should be conducted to develop and

implement a collaborative decision-making process or pilot study through incorporating the principles and techniques of the Collaborative Learning Approach.

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APPENDICES

Appendix A. Examples of cross-sector collaborations involving forest sector companies for new products/systems development.

Companies/sectors involved		Collaboration products / systems	Region/Continent
Partner 1	**Partner 2**		
Potential collaborations [a]			
Forest company	Chemical company Energy company	Advance biofuel	Europe
Forest company	Energy company	Biogas	Europe
Ongoing collaborations [b]			
Forest company	Energy company	Biodiesel	Europe
Forest company	Packaging company	Packaging materials	Europe
Forest company	Household products	Bioplastic kitchen utensils	Europe
Forest company	Textile company	Wood-based textile fibers	Europe
Forest company	Fashion company Holding company	Wood-based textile fibers	Europe
Forest company	Chemical company Chemical Company Packaging company	Wood-based bioplastics	Europe
Forest company	Packaging company	Wood-based paperboard	Europe
Forest company	Packaging company Food company	Wood-based packaging	Europe
Forest company	Technology company	Automated lumber grading system	North America
Forest company	Energy company	Biofuel	North America
Forest company	Energy company	Advanced biofuels	North America
Past collaborations [c]			
Forest company	Energy company	Biodiesel	Europe
Forest company	Fiberglass Company	Soundproof wall systems	North America
Forest company	Technology company	Biofuels and bioproducts	North America
Forest company	Energy company	Biofuels	North America
Forest company	Automaker company	Wood-based auto parts	North America

[a] Companies involved have signed a contract or agreement to start a collaboration in the future.
[b] Companies have established an agreement to build an industrial demo plant or produce and bring to market new wood-based products.
[c] Collaborations that partners chose not to commercialize.

Appendix B. Interview protocol used during phase two.

The interview questionnaire of "Evaluation of cross-sector collaborations in transition toward the bioeconomy: Benefits, challenges, and opportunities in the forest sector"

1. Could you please describe your company's general approach (or philosophy) to cross-sector collaboration?

2. In how many cross-sector collaboration initiatives is your company involved, when did it (they) start and what is (are) the main goal(s) of your collaboration(s)?

3. How was the cross-sector collaboration set up (including legal structure)? what were the drivers or issues that drove the creation? Which companies are involved, how were the partners selected?

4. How would you describe your company's experience in collaborative relationships? What were the most important benefits? What were the key challenges and barriers to the collaboration?

5. How does cross-sector collaboration contribute to new product development in your company?

6. How does cross-sector collaboration contribute to the competitiveness of your company?

7. How do you think the organizational culture of your company influences the collaborative relationship?

8. What do you think should be improved regarding your company's experience in collaborative relationships?

9. Are there any other comments you would like to add, or do you have any questions for me?

Thank you very much for your time and participation!

Appendix C. Interview protocol used during phase three.

The Interview Protocol of "Determining the collaborative potential in Oregon's forest products industry".

This study aims to assess the potential of Oregon's forest sector companies to implement cross-sector collaborations with companies from neighboring sectors (e.g., textiles, energy, chemicals, or plastics, etc.), as well as explore barriers for them to implementing collaboration across sectors for developing new products. What follows are a series of questions to determine and understand collaborative potential. Your individual responses will be kept confidential.

1. Is your company involved in any collaboration initiative?

Condition: If yes is selected, is it inside or outside the forest sector? Could you please briefly describe it? Skip to question 2.

Condition: If no is selected, skip to question 6.

2. What would need to change to make cross-sector collaboration attractive for your company?

3. What sector(s) or actor(s) (industry players) would be most attractive for collaboration?

4. What would collaborating with these sectors/actors potentially do for your company?

5. What would be needed for your company to be an effective collaborator (e.g., skills, knowledge, resources, investment, etc.)?

6. Where is the best potential or opportunity of your company for being an attractive collaborator?

7. What other methods or approaches would your company use to pursue its goals?

8. In Appendix 3.1., there is a list of the main challenges, risks, and barriers, as well as the drivers and benefits associated with implementing collaborations involving forest sector companies. Do the drivers, benefits, and challenges identified in my earlier research make sense from your company context?

9. Are there any other comments you would like to add, or do you have any questions for me?

Thank you very much for your time and participation!

Appendix C.1 Drivers, benefits, and challenges associated with cross-sector collaborations led by forest sector companies.

Scope	Drivers	Benefits	Challenges
Cross-sector collaborations for developing new forest-based products	Sustainability / Bioeconomy	Profitability increase	Capital-intensive investment
	Develop new forest-based products	Learning new knowledge & skills	Lack of consistent government policy & regulatory support
	Changes in policies and regulations	Costs reduction	Technology in early-stage development
	Changes in the industry	Access to new markets	Long-term technological development
	Changes in the companies	Innovation and NPD	Changes in company strategy
	Changes in consumer preference	Value creation	Inadequate return on investment
	Increase profitability	New technology development	High return on investment expected
	New business opportunities	Competitive advantage	High Production costs and low yields
	Business diversification	Improve company image	Competitive & technological uncertainty
	Risk mitigation	Employee development	Employees' resistance to change
	Companies complementary skills	Trusted long-term relationships	Differences in company culture

Appendix D. Interview questions organized by the framework's dimensions.

Dimensions	Interview questions
Relationship	1. Is your company involved in any collaboration initiative? 2. What would need to change to make cross-sector collaboration attractive for your company? 3. What sector(s) or actor(s) (industry players) would be most attractive for collaboration? 4. What would collaborating with these sectors/actors potentially do for your company?
Procedure	1. Where is the best potential or opportunity of your company for being an attractive collaborator? 2. What other methods or approaches would your company use to pursue its goals?
Substance	1. What would be needed for your company to be an effective collaborator (e.g., skills, knowledge, resources, investment, etc.)? 2. In Appendix A.1., there is a list of the main challenges, risks, and barriers, as well as the drivers and benefits associated with implementing collaborations involving forest sector companies. Do the drivers, benefits, and challenges identified in my earlier research make sense from your company context?
Connections	1. What are the major connections among relationship, procedure, and substance factors you identified? 2. What relationship, procedure, and substance factors can be improved to increase collaborative potential?

Source: Daniels and Walker (2001, 164p).

Appendix E. Matrix used for evaluating the interrelationships between dimensions by themes.

Participants	Progress Triangle framework's dimensions					
	Relationship			Procedure		Substance
	Willingness to collaborate (Sectors of interest)	**Actual and potential benefits**	**Changes and needs**	**Capacity to collaborate**	**Alternatives to collaboration**	**Issues, challenges, and barriers**
Company 1	Not interested in CSC		Generational change		Organic or in-house development Diversification	Traditional family attachment and paternalism
Company 2	Involved in CSCs	Diversification New businesses Access to markets	Creativity/Innovation Relationship building	Solid balance sheet Geographical reach Receptive & thought people	Merger/acquisition Organic or in-house	Lack of expertise, knowledge, and qualified personnel
Company n						

Appendix F. Collaborative Potential Screening Worksheet (CPSW) (modified from Walker and Daniels 2005).

Step one. Describe the decision situation (potential collaboration) and its context.

A. New business opportunities are presented for forest sector companies outside of the forest products industry (e.g., demand for greener products, bioeconomy transition, etc.).

B. Most forest sector company interviewed are interested to collaborate.

C. Interviewees' expressed that the forest industry and market are volatile and unstable.

D. Interviewees' felt that partnering with other industries would help their companies to achieve many benefits.

E. Meaningful, respectful communication and dialogue between potential partners are likely to be presented.

Step two. Determine the ***perceived need for collaboration***, according to the statements described above.

- High (X)
- Moderate ( )
- Low ( )

Step three. Rate the decision situation on 5-point scales according to the interviewee's responses and perspectives in the following criteria.

Relationship dimension

1. How many companies and spokespersons would be involved?

1	2	3	4	5	A	B	C	D	E
Few companies, spokespersons (2 or more)				Many companies, spokespersons (4 or more)	(1)	2	3	4	5

2. Are these companies willing to collaborate?

1	2	3	4	5	A	B	C	D	E
They are interested and committed to collaboration				They are not interested and/or committed to collaboration	1	(2)	3	4	5

3. What is the history about partnering with other industries?

1	2	3	4	5	A	B	C	D	E
Is completely new, little history				Is a long, volatile and tense history	1	2	(3)	4	5

4. What is the degree of trust and dialogue among potential partners?

1	2	3	4	5	A	B	C	D	E
There is reasonable trust and dialogue				There is little or no trust and dialogue	1	2	3	(4)	5

5. What outcomes would be generated for companies?

1	2	3	4	5	A	B	C	D	E
Numerous and adaptive to benefit all				Limited and rigid to the benefit of some	(1)	2	3	4	5

Procedure dimension

6. Are there other alternatives to collaboration?

1	2	3	4	5	A	B	C	D	E
Few alternatives exist to achieve company's goals				Many alternatives exist to achieve company's goals	1	2	3	4	(5)

7. Are the key people involved trained to work with other industries?

1	2	3	4	5	A	B	C	D	E
Should be able to work well with one another				May have difficulties working well	1	2	3	4	(5)

8. Are decision authorities, decision makers or decision space for companies defined?

1	2	3	4	5	A	B	C	D	E
Clearly defined				Poorly defined	(1)	2	3	4	5

9. Is relevant information about potential collaborations accessible?

1	2	3	4	5	A	B	C	D	E
Is publicly available				Is not publicly available	1	2	3	4	(5)

10. What is the potential for a collaboration agreement to be blocked by an external decision authority?

1	2	3	4	5	A	B	C	D	E
Is limited, parties are autonomous				high, parties are regulated by external authorities	(1)	2	3	4	5

Substance dimension

11. Is there any resource/change needed for companies to collaborate?

1	2	3	4	5	A	B	C	D	E
Few resources or changes are needed				Many resources or changes are needed	1	2	3	4	(5)

12. Are the issues/challenges/barriers to collaboration clearly defined?

1	2	3	4	5	A	B	C	D	E
Clear and well defined				Controversial, not clear.	1	2	(3)	4	5

13. Do the issues/challenges/barriers vary among the companies?

1	2	3	4	5	A	B	C	D	E
Little variation exists				A large variation exists	1	2	3	4	(5)

14. Is new knowledge required to solve the issues/challenges/barriers?

1	2	3	4	5	A	B	C	D	E
Little new knowledge/ training is needed				Joint learning/training is needed	1	2	3	4	(5)

15. Is knowledge or information needs accessible and understandable?

1	2	3	4	5	A	B	C	D	E
Is accessible in an understandable format				Is not accessible / or not understandable	1	2	3	4	(5)

	A	B	C	D	E
Totalize the rating points for each decision criteria. A greater score indicates lower collaborative potential. Range: Low (15 - 34 points); moderate (35 - 55 points); high (56 - 75 points).			51		