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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 to evaluate costs and savings generated are key challenges to forest companies implementing cross-sector collaboration.

Keywords: Cross-sector collaboration, inter-sector collaboration, forest companies, forest industry, systematic literature review.
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. 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 1 provides an overview of the literature review adopted.

[insert Figure 1 around here]
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 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.

### 3. Results and Discussion

#### 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”.

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.

3.2.1 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 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).

3.2.2 Drivers of cross-sector collaboration in the forest industry

Table 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 includes a detailed description of the individual drivers identified. Most studies report external collaborative drivers, but significant internal drivers are also identified. Table 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.

[insert Table 1 around here]

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.

3.2.3 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 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.

3.2.4 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 the by 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.

3.2.5 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 is 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 (Hämaläinen 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 (Hämaläinen 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 of the 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 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 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.

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.

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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References


Scott, J., 2017. Social Network Analysis. SAGE.


Table 1. Categorization of cross-sector collaboration drivers in the forest industry from the systematic literature review (n = 109 drivers).

Table 2. Theoretical framework for cross-sector collaboration in the forest industry
Figure 1. Overview of the systematic literature review.

Figure 2. Implementation process for cross-sector collaboration (modified from Ansell and Gash 2008).
Table 1. Categorization of cross-sector collaboration drivers in the forest industry from the systematic literature review ($n = 109$ drivers).

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

Note: Most studies have more than one driver.
<table>
<thead>
<tr>
<th>Theory</th>
<th>Articles</th>
<th>Scope</th>
<th>Drivers</th>
<th>Benefits</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborative network</td>
<td>Fortier et al. 2013 Strand 2009 Wyatt et al. 2013 Wyatt 2008</td>
<td>Explores how communities and companies develop long-term, collaborative partnerships on issues such as corporate responsibility, sustainable forestry, etc.</td>
<td>Corporate social responsibility, Sustainable forest management,</td>
<td>Savings, Waste reduction, Improved environmental performance, Avoided greenhouse gas emissions, New products development, Manufacturing optimization, Competitive advantages, Resource exchange by companies, Operations improved, Cost-effective solutions, Less environmental load, Eco-innovative solutions, Reutilization of waste resources,</td>
<td>Forestland management, Economic and societal challenges</td>
</tr>
<tr>
<td>Industrial symbiosis networks</td>
<td>Husgafvel et al. 2016 Karlsson and Wolf 2008 Martin and Eklund 2011 Pakarinen et al. 2010 Rosa and Belobrodko 2015 Sokka et al. 2011</td>
<td>Outlines research initiatives and new products development from forest-based waste and evaluates the global implications of the industrial symbiosis for the forest industry.</td>
<td>Environmental performance, Sustainable development, Increase profitability, System cost reduction, Increase profitability,</td>
<td>Environment performance, Sustainable development, Increase profitability, System cost reduction, Increase profitability,</td>
<td>Difficult to determine savings, Creation of innovative technology, Keep low operating costs, Lack of trust among partners, Leadership role,</td>
</tr>
<tr>
<td>Network governance</td>
<td>De Loe et al., 2016 Zander et al. 2016</td>
<td>Explores how the drivers of network governance might enhance collaboration in the wood industry to facilitate efficient utilization of renewable resources.</td>
<td>Waste reduction, Environmental sustainability,</td>
<td>Waste reduction, Environmental sustainability,</td>
<td>Lack of trust among partners, Leadership role,</td>
</tr>
<tr>
<td>Social network analysis</td>
<td>Velenturf 2016</td>
<td>Highlights industrial symbiosis for collaboration among industries to use bio-based products and generate power and fuel from secondary biomass resources.</td>
<td>Resource efficiency, Increase business growth,</td>
<td>Resource efficiency, Increase business growth,</td>
<td>Keep collaboration in time,</td>
</tr>
</tbody>
</table>
Overview of the systematic literature review.

Stage 1
Literature searches in Web of Science.

Review of 210 abstracts of articles on collaboration.

14 articles on collaboration in forest companies to read and analyze.

Stage 2
Literature searches in Google Scholar.

Review of 350 abstract, resulting in 17 additional articles.

31 articles in the database to read, analyze and discuss.
Implementation process for cross-sector collaboration (modified from Ansell and Gash 2008).