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Exploring the unknowns – State of the art in qualitative forest-based sector foresight research

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ABSTRACT

The forest-based sector is facing one the greatest transitions in its history in the face of global megatrends. Globalization, sustainability challenges and the ICT sector have put the world in a new light. Whereas some of the recent developments have resulted in challenges for the traditional forest industry, many positive expectations and opportunities are also seen to arise in the form of the transition to a sustainable bio-economy. However, to be able to fully seize the opportunity, the industry has to navigate through contingency where preparedness can have a major impact. Foresight as a strategic approach can help to prepare and sensitize decision-makers to be prepared for the future. Foresight is a process aimed at understanding the various and alternative developments of the future better. In this review, we aim to find out what the state-of-the-art of qualitative foresight in the context of forest-based sector is. Forest sector foresight remains a nascent stream in peer-reviewed literature despite the small increase in articles since 2010. Foresight has been applied relatively evenly across the sub-sectors, attention having been predominantly on adaptive approaches. Foresight studies could be classified based on their objectives and types of output into three main categories: *Identifying Drivers and Trends*, *Management of Change* and *Visioning*. Notably, almost all the scientific foresight literature deals with sectoral level, and lacks organisational points of view. Foresight could also provide an opportunity to include stakeholder engagement beyond business-as-usual, which seems to remain currently relatively marginal. The findings suggests that foresight in the forest sector is not entirely novel, but still developing. Many opportunities to fully capture the potential lie ahead and micro level perspectives could be enhanced in the literature.

1. Introduction & background

1.1. The forest-based sector in transition

The forest-based sector (FBS) has changed substantially over recent decades, and is facing some of the greatest upheavals in its history. Globalization, shifts in global economic power, changes in consumer preferences, increased awareness of sustainability challenges, and a surge in ICT and big data methods have had a major impact on the FBS (Hansen et al., 2013; Hetemäki, 2015; Pätäri et al., 2016), and these megatrends create both challenges and opportunities for the future. Although some of the traditional forest products might face declining demand, especially in the western markets (Hetemäki and Hurmekoski, 2016; Jonsson, 2013; Jonsson et al., 2018; Latta et al., 2016), the need for substitutes for fossil-based raw materials creates new market opportunities for wood-based industries and may help in realising international climate commitments and pathways to more sustainable development.

The FBS can play a significant role in replacing fossil-based materials and energy carriers. For instance, a few potential applications where wood may have increasing importance, such as renewable and recyclable lignocellulose-based materials, can replace many materials in the chemical and textile industries (Arasto et al., 2021). Bio-polymers can replace plastics, and an increasing proportion of wood construction and engineered wood products may replace carbon-intensive construction materials. This renewal is also often referred to as a move toward a bioeconomy or wood-based bioeconomy, which has gained extensive political support within the EU and member states (Antikainen et al.,

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2017; D'Amato et al., 2017; Hagemann et al., 2016).

However, this renewal of the traditional forest-based sector is still only in its infancy. According to the previous literature, the FBS will face many critical business challenges to navigate through, for example, institutional stickiness and lock-ins of established actors and, increased complexity of supply chains and product portfolios, among other things (Antikainen et al., 2017; Arasto et al., 2021; Björkdahl and Börjesson, 2011; Hansen et al., 2013; Näyhä, 2020a). Overall, the bioeconomy and circular bioeconomy call for actors within the network and supply chain to adopt changing roles and to become more intermingled (Antikainen et al., 2017; D'Amato et al., 2017; Guerrero and Hansen, 2021; Näyhä, 2020a). Hence, in times where the complexity is increasing, the pace of change is faster and the future offers more opportunities than ever, preparedness is key. Foresight as a strategic approach can help to prepare and sensitize decision-makers to adapt to such uncertainties better, which can be an advantage against competitors (Hansen et al., 2021; Rohrbeck and Kum, 2018).

1.2. Foresight a systematic means to explore futures

Foresight is a process aiming at better understanding of different and alternative future developments. Futures studies and foresight both include a range of methodologies that systematically aim at revealing possible and alternative futures and inspire discussion about various options (Clardy, 2020; Cuhls, 2003; OECD, 2021; Valciukas and Bell, 2003). Thus the aim is not to predict exactly what is going to happen in the future, but to increase the awareness of alternative pathways. The assumption is that the future is not deterministic: today's actions produce tomorrow's consequences. According to Valciukas and Bell (2003), futures studies have several purposes, most of all, the study of probable, possible, and preferable futures, and interpreting the past and orientating the present. However, although futures studies and foresight are not mutually exclusive they are distinguished by a slight difference in character. Whereas futures studies is more theoretical in its viewpoints, analysing epistemological and ontological foundations of futures knowledge, foresight takes rather action-oriented viewpoint and employs processes to explore alternative future developments and their consequences (Dufva and Ahlqvist, 2015a). This study focuses on the latter. In addition, according to Schatzmann et al. (2013), the term foresight emphasizes its exploratory nature and extends to normative approaches in futures studies. Similarly, a distinction should be made between the nature of foresight and forecast. Cuhls (2003) states that the main divergence between foresight and forecasting stems from a few characteristics, that is, a forecast is seen rather as quantitative than qualitative, while foresight is typically more qualitative than quantitative. Forecasting strives to enquire what the future of a selected area will likely look like whilst foresight seeks information on a range of futures for priority setting (Cuhls, 2003).

Interesting questions related to foresight include the factors which are driving the change, how the interconnected drivers and phenomena behave in a dynamic environment, and how they can be interpreted, recognized and understood. Rohrbeck et al. (2015) argues that in the field of foresight, the terminology is ambiguous and the academic research remains weakly organized.

Additionally several concepts of foresight are used relatively synonymously, including organisational foresight, strategic foresight, industry foresight, managerial foresight and corporate foresight, despite there being distinctive definitions (see Rohrbeck et al., 2015). All these concepts build on the same basic assumptions of generic foresight described by Berger et al. (2008): multiple futures are possible, change and drivers are detectible and the future can be influenced. Further, Cuhls and Johnston (2006) also distinguishes between 'in business' and 'for business' foresight. 'In business' is performed by a business organisation independently for a specific purpose, whereas 'for business' can be performed by any actor or organisation, e.g., academia, but can be applied for business purposes.

This study takes a generic approach to foresight in that we think the foresight concept entails action orientation, strategic perspectives and broad recognition. Therefore our understanding is closely related to the definition given by (Slaughter, 1997 p.2): "*Strategic foresight is the ability to create and maintain a high-quality, coherent and functional forward view and to use the insights arising in organisationally useful ways; for example: to detect adverse conditions, guide policy, shape strategy; to explore new markets, products and services.*"

The development of business models has been linked to strategic foresight, since the strategies are closely related to external factors impacting competitiveness (Hines and Bishop, 2007; Vecchiato and Roveda, 2010). Although it has been recognized that foresight and the use of foresight information is beneficial for organisations, it is not often a fully-fledged practice in businesses. Corporate foresight should therefore be a more integral part of management systems (Hines and Gold, 2015; Rohrbeck et al., 2015). Corporate foresight is defined by Rohrbeck and Kum (2018 p. 106) as "a set of practices that enable firms to attain a superior position in future markets" placing more emphasis on a firm's actions rather than a general examination of possible futures.

1.3. Foresight in the forest-based sector

Despite the current needs and history of foresight analysis in the forest-based sector, forest sector foresight remains a nascent stream in peer-reviewed literature, with evolving definitions and applications. In the forest sector, foresight seems to have been focused on quantitative outlook studies, focusing on forest product market projections and 'what if' projections, with the aim of directing decision-making through examining the impacts of specific exogenous shocks and forecasted macroeconomic developments (Hurmekoski and Hetemäki, 2013). However, only a proportion of FBS relevant analyses are published in scientific journals in comparison to private consultancy reports or reports by international organisations such as FAO. More generally, Pelli and den Herder (2013) note that foresight thinking has been present in the forest sector in many high-level decision-making processes, such as vision building and goal setting (bioeconomy strategies), strategy formulation (the foresight work of private enterprises), technology platforms (the Forest-Based Technology Platform), and policy-making (Forest Europe and EU Forestry Strategy processes).

One challenge with quantitative model-based outlooks and scenarios is that they tend to be exclusively based on extrapolation of past data, which might lead to ignoring developments that the models cannot capture, such as substitution in the forest products end use markets (Hetemäki and Hurmekoski, 2016). Correspondingly, qualitative studies have their own limitations, such as not foreseeing the interactions between multiple variables, and quantitative studies have also evolved in recent decades to capture more heuristic rather than deterministic approaches (Verkerk et al., 2021). The choice of a foresight method is however contingent on the intended output of the foresight activity. Popper (2008) defines two fundamental attributes for the methodical choice, namely *nature* and *capabilities*, e.g., the nature of a method is characterized by whether a method is qualitative, quantitative, or semi-quantitative quantifying subjectivity. Capabilities define the ability of a method to gather or process information based on the input information such as evidence, expertise, interaction and creativity (see Fig. 5.). According to Popper (2008), these attributes are neither mutually exclusive nor restrictive.

According to existing reviews, forest sector foresight seems to have been divided into model driven outlook studies and a more heterogeneous set of foresight studies (e.g., Hurmekoski and Hetemäki, 2013; Toppinen and Kuuluvainen, 2010), of which the former appears more common and established. Model driven outlook studies may have achieved a broader coverage by addressing issues related to climate change mitigation, the sufficiency of wood resources, and trade-offs between ecosystem services. The latter group of studies consists of more heterogeneous, non-established topics and approaches, and therefore

remains less organised. Therefore, this review targets the latter focus, often approached using qualitative methods.

Although utilizing qualitative foresight activities in the FBS is not entirely lacking for the business and policy purposes (see, e.g., Hansen et al., 2021; Kunttu et al., 2021; Luhas et al., 2021; Näyhä et al., 2015; Sandström et al., 2020; Toivonen et al., 2021) to our knowledge there is no systematic review available on the extent of and how foresight, with a qualitative approach emphasis, has been used in the context of the FBS. This creates a clear knowledge gap, as the forest-based sector has been argued to be too focused on managing acute problems instead of considering the long-term future (Nilsson, 2015), many of issues that are sensitive for competitiveness are emerging beyond the forest-based sector's control (Matthies et al., 2020), and the current FBS is facing challenges in understanding future generations, their values, consumption habits and needs (Näyhä, 2020b).

1.4. Objectives of the study

The qualitative methods has been selected as the subject of this study because the foresight benefit from utilizing combined and mixed approaches to create a deep and comprehensive understanding of futures (Gordon and Glenn, 2009), and to bring in more flexible aspects to complement already existing quantitative future-oriented studies, foresight, scenarios and outlooks (see, e.g., Aggestam and Wolfslehner, 2018; Hoogstra-Klein et al., 2017; Hurmekoski and Hetemäki, 2013; Pelli, 2008).

In our systematic review, we identify commonalities and differences in this research literature and also recognize potential avenues for further research on the topic by focusing on the following questions:

i. which journals are used to publish foresight literature in the forest-based sector context and when did the literature emerge?
ii. what is the geographical and sub-sectoral scope of foresight studies in the forest-based sector context?
iii. what research methods have been used in the context of foresight and the forest-based sector?
iv. what are the general objectives and outcomes of foresight studies in the forest-based sector?
v. are there any potential knowledge gaps based on the literature reviewed?

Next we present the data and its collection and analysis, followed by findings and discussion. Finally, the conclusions are drawn from the data.

2. Methods and data

This review follows the PRISMA approach for systematic literature reviews (Moher et al., 2009), as demonstrated in Fig. 1.

2.1. Data collection

The data was collected and identified using future studies, foresight and FBS-related search terms limited to the English language, peer-reviewed journal articles from two well-established databases, Scopus and Web of Science. See the search string used to search articles in Appendix A. The search string consists of two parts, a futures studies related part and the FBS related part.

Searches were conducted in January 2021. The initial identification phase was done by applying exclusion criteria, articles not focusing clearly on the FBS being excluded. After duplicates were removed and initial exclusion, the data consisted of 142 items.

At the next stage, the data was screened based on abstracts using exclusion and inclusion criteria, with a focus on qualitative foresight in the context of FBS. Articles were selected if a publication was clearly

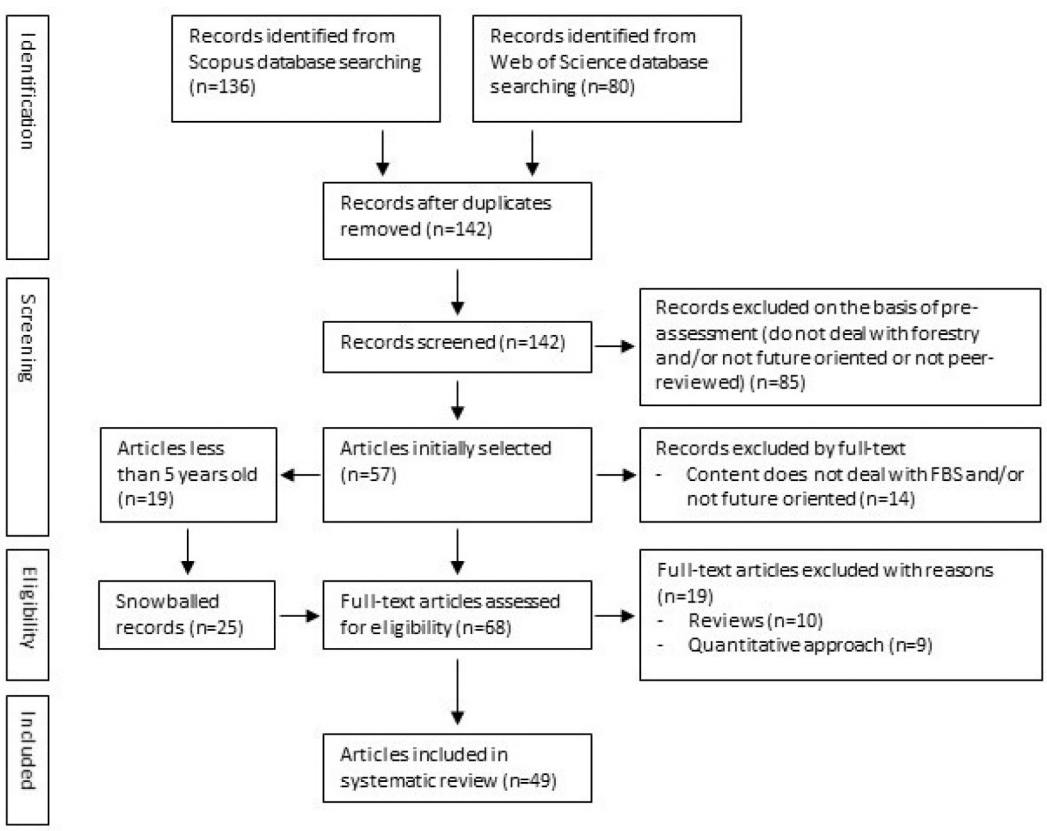

Fig. 1. PRISMA selection process for literature review (adopted from Moher et al., 2009).

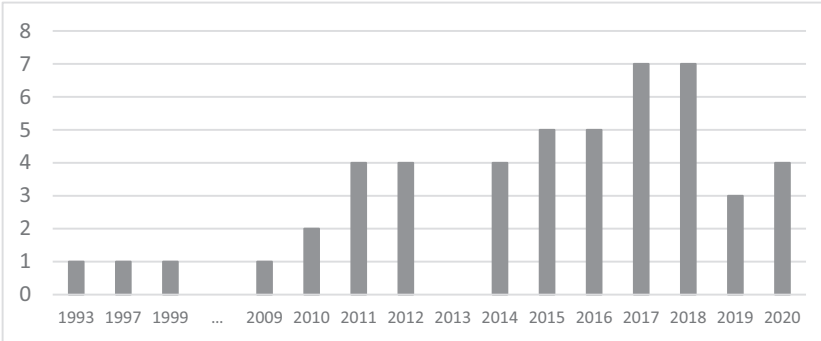

Fig. 2. Publication of articles over the 1993–2020 time span.

future-oriented and forward-looking, and had direct connection to FBS, either concerning part of FBS's value chain or a policy or strategy having a direct impact on FBS. Therefore, the subject of excluded publications was not part of the value chain, or the subject was otherwise indirect, e.g., exclusions of estimations of carbon sinks, articles focusing on agriculture, construction without specific focus on wood-based materials or waste management, or if the article was not future-oriented per se. Subsequently, after the initial identification, screening and exclusion ($n = 85$), the data consisted of 57 peer-reviewed journal articles.

The data extracted from the publications included the i) source journal and full reference, ii) authors, their affiliate institutions and countries of the affiliate institution, iii) relevance of an article (connection to FBS and future orientation), iv) aim of the study v) methods used and means of data collection and vi) objective of foresight. Similarly, the data was categorized into five forest sector sub-sectors (categories are specified in the Objectives of foresight section below), based on the focus of an article.

The data was extracted by the first author and the other authors checked the samples of extraction and the relevance of data extracted. As a result of screening, further publications ($n = 14$) were excluded based on these criteria. Consequently, 43 articles were included in the full eligibility assessment.

In addition, the list of references of all initially selected articles published within a maximum of five years ($n = 19$) were screened for articles that might have been missed with the search string used. As a result of this snowballing exercise, further 25 articles concerning the forest-based sector in the context of foresight or future orientation were included for the final assessment of eligibility. After the eligibility assessment of snowballed records; 15 articles were added as part of the final systematic review sample ($n = 49$).

The objective of this study being to determine the state-of-the-art qualitative foresight in the FBS, at the final stage of eligibility assessment reviews and publications with strictly quantitative approach were excluded ($n = 9$). However, publications combining quantitative and qualitative approaches were included in the final assessment. Similarly, reviews were excluded as the focus was on primary sources. The data thus consists of 49 items for final qualitative analysis. See the full list of reviewed articles in Appendix B.

Furthermore, the articles sampled are categorized as *for business* foresight and hence, foresight conducted *in business* itself is not included in the data. Foresight *for business* is conducted outside of a business organisation, but the results can be often used in a managerial or organisational context. Further, foresight *for* business can be more general and process- rather than results-oriented (Cuhls and Johnston, 2006).

The search string used contains search words such as Delphi and backcasting, which are also considered as methods and research approaches which may cause limitation in terms of unbalanced representation of methods. Also, regardless of extensive searches, careful consideration of search string, use of multiple databases and snowballing exercise this review does not claim to be exhaustive of all articles on foresight related articles in the FBS.

2.2. Data analysis

The analysis coded and classified the articles. The information from articles was first collected and analysed, including publication year, journal and origin of authors. The scope of publishing journal was also examined.

Moreover, the data was examined according to geographical and sub-sectoral scope. Geographical classification was done according to the entity observed in the studies, *regional, national, sub-national* entity or *no geographical scope*. The sub-sectoral classification was done by the authors as follows. The data contained six different identifiable sub-sectors. Studies were classified into a general *forest sector* category if no specific sub-sectoral scope was defined. The *forest management and land-use* sector concerns studies focusing on issues that are part of the FBS's value chain before processing, such as multiple use of forests. The *chemical forest industry* category includes pulp and paper, packaging, and a range of new forest products based on chemical processing or its by-products. This group also includes studies concerning biorefineries if no other specific product was specified, and liquid biofuels. The *mechanical forest industry* category includes the non-chemical part of wood processing and advanced solid-wood and construction industry were included in this group as well. The *bioeconomy* category consists of publications concerning the bioeconomy without specific definition of its characteristics or product category. Lastly, the *bioenergy* category deals with solid-wood based energy production.

Secondly, the data was analysed according to the nature of the methods, frequency of methods used and by possible combinations of methods. This analysis classified research methods following Popper's (2008) foresight diamond framework according to the methods' ability attributes in creativity, expertise, interaction and evidence. The ability attributes form the basis of gathering information. *Creativity* is characterized by a mixture of imaginative and original thinking, innovativeness, imagining non-existent things such as science fiction literature and is often provided by individuals such as artists or can be created in a group, as in brainstorming sessions. *Expertise* relies heavily on individuals who can provide information on a specific subject or sector, obtained by access to an exclusive source of information or knowledge acquired during an extensive professional career. Expertise is often used in top-down decisions, supporting opinions and views and providing advice holistically. *Interaction* is established on perception, "expertise often gains considerably from being brought together and challenged to articulate with other expertise (and indeed with the views of non-expert stakeholders)" (Popper, 2008. p.65). Hence, the bottom-up approach of interaction complements expertise and evidence. Interaction is also participatory, highlighting the legitimacy and democratic nature of foresight. *Evidence* seeks to understand some particular phenomenon by way of interpreting statistics and other reliable documentation or

information that can form the basis of analysis (Popper, 2008). Popper (2008) further divides foresight methods according to their relative frequency into three categories; widely used, commonly used, and less frequently used.

Finally the data was analysed and classified in terms of the objective of foresight (see the Objectives of the foresight section). Articles were examined in connection with the study objective and research questions to find out what the purpose of foresight had been. Based on the analysis, data was classified into three general groups generated endogenously.

3. Results & discussion

3.1. Journals and their scope for FBS foresight literature, time span of published articles and origin of authors

Over half, 55% of the 49 identified articles are published in forest science journals ($n = 27$), followed by the journals with foresight scope, 27% ($n = 13$) and those with other scope, 18% ($n = 9$) (see Table 1). Forest Policy and Economics was the most frequently occurring journal ($n = 10$) to publish articles regarding foresight in the FBS.

In our sample, 49 articles, 128 individual contributing authors were identified from 54 different affiliated institutions. This indicates the community of researchers being quite limited. Most of the publications originated from Europe, especially the Nordic countries (Fig. 3.). This may be due to the considerable historical importance of the FBS in the export market driven Nordic countries. Similarly, Iden et al. (2017) found in their systematic literature review regarding foresight activities in general that the top three countries the publications originated from were in Europe (UK, Germany and Italy). Furthermore, Jemala (2010) found that European and Nordic countries are among the higher-ranking countries in terms of the number of national foresight initiatives. In addition, Popper (2008) analysed 850 foresight cases attributed to a specific country; Europe represented the majority (69%) of the cases, followed by North America (13%), and South America (13%).

3.2. Geographical and sub-sectoral scope of foresight in the context of FBS

Most of the published foresight literature in the FBS context has a national scope 53% ($n = 26$) followed by regional 14% ($n = 7$), sub-national 10% ($n = 5$), multi-national 8% ($n = 4$) and multi-regional scope 6% ($n = 3$). Four articles, 8%, did not specify any geographical scope. Finland was the most common ($n = 6$) national scope followed by Sweden (n = 5) and Norway (n = 4). Germany (n = 3) and Ireland (n = 3) were both nominated more than once. Other national scopes were Australia ($n = 1$), Canada (n = 1), China (n = 1), Netherlands (n = 1) and Russia (n = 1).

Table 1
Publication of outlets of data included and the scope of the journal.

Source journals	Scope of journal		
	Forest sciences	Foresight	Other
Forest Policy and Economics	10		
Technological Forecasting and Social Change		5	
Forests	4		
Futures		4	
Journal of Cleaner Production			4
Journal of Forest Economics	3		
Canadian Journal of Forest Research	2		
Foresight		2	
Forest Ecology and Management	2		
Scandinavian Journal of Forest Research	2		
Others	4	2	5
n	27	13	9

The articles sampled were published between 1993 and 2020 (Fig. 2.). However, a majority of articles, 71% ($n = 35$), were published in 2014 or later. A slight increase of interest in foresight at the FBS can be seen over time, but, recognizing the limitations of the size and scope of data, no strong conclusions can be drawn.

Regional scope was divided between Europe (n = 6) and the Nordic countries (n = 2). Sub-national geographical scopes were typically states, provinces or regions such as Pennsylvania, USA (Egan and Jones, 1997); Northern Queensland, Australia (Herbohn et al., 1999); and Flanders, Belgium (Vandermeulen et al., 2012). Multi-national scopes were typically comparative between relatively similar countries in terms of the forest industry, e.g., Finland and Sweden (Toppinen et al., 2019, 2018) or Sweden and Canada (Keskitalo et al., 2011) or the USA, Canada, Sweden, and Finland (Hurmekoski et al., 2018a). Similarly multi-regional studies were relatively comparative by nature, e.g., between Scandinavia and North America (Näyhä and Pesonen, 2012).

Studies without direct geographical scope are mostly conceptual papers focusing on method development. However, Dufva and Ahlqvist (2015b), for example, focus on the elements of foresight as a system and how they contribute to the creation of futures knowledge, albeit the South Australian forest industry has been used as a case study.

The scope of the foresight studies in the data was distributed relatively evenly across the sectors (Fig. 4). No single sector stood out clearly. Articles concerning the forest sector in general ($n = 11$) and the chemical forest industry (n = 11) were most frequent. In case of the forest sector in general, the articles typically concern external issues and are relatively policy oriented. These articles concentrate on issues such as changes in the macro-environment and the whole sector's ability to adapt to change; for example, to discuss changes in global forest markets and its implications for a national forest sector (Jonsson, 2011), or how the forest sector positions itself in the face of climate, energy and demographic trends (Lindahl and Westholm, 2012).

The articles focusing on the chemical forest industry, biorefining and liquid biofuels sub-sector (n = 11) mostly concentrate on capability as well as options to adapt to the changing operational environment. Furthermore, there is clearly striving to understand the pace and direction of transformation from pulp and paper industry to biorefining. As an example, Brunnhofer et al. (2020) empirically assess the factors influencing biorefinery transitions utilising SWOT, for example; Toppinen et al. (2017) map expert views and concerns related to the future of biorefining, while Olsmats and Kaivo-oja (2014) identify the implications of megatrends for the packaging sector and initiate a future-oriented strategic dialogue based on these.

The forest management and land-use sub-sector represents a considerable group ($n = 10$) in the data. These articles typically concern issues such as how to reconcile contradictory and conflicting interests in the use of forests. For instance, Filyushkina et al. (2018) assessed the impact of various forest management alternatives and Wallin et al. (2016) aimed to facilitate discussion among the local stakeholders and relate the local level to a national discussion. Forest management and land-use related papers can be seen as the most participatory and stakeholder-inclusive, and the most common objective of this group is visioning.

The studies which include the mechanical forest industry and (wood) construction sub-sector ($n = 9$) have many similar characteristics to the chemical industry's scope, the main defining characteristics being understanding the pace, direction and adaptive implications of a changing environment. For example, Nuutinen et al. (2009) analysed the operational environment and drew managerial implications, while Hurmekoski et al. (2015) explored the potential of wooden multi-story construction in Europe.

Overall, the similarities between the chemical and mechanical forest industry sub-sectors explore adaptive strategies for the future, and both sub-sectors have rather strong managerial implications in foresight. Instead of striving to understand the environment, the articles within these scopes pursue understanding of the implications of changes in a given environment.

The bioeconomy sub-sector ($n = 6$) is defined by an attempt to understand how bioeconomy becomes a practice and in what direction the

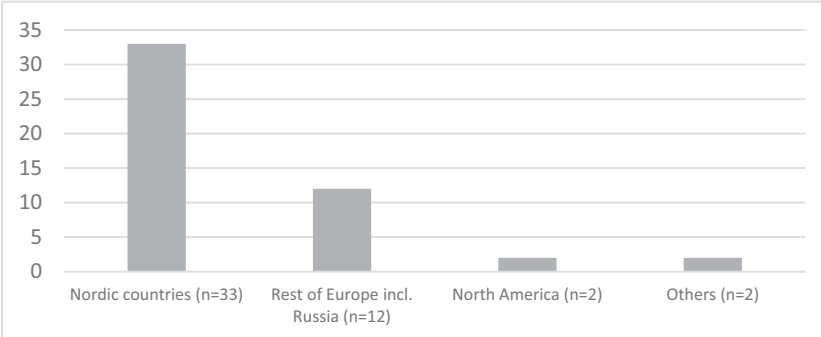

Fig. 3. Origin of authors.

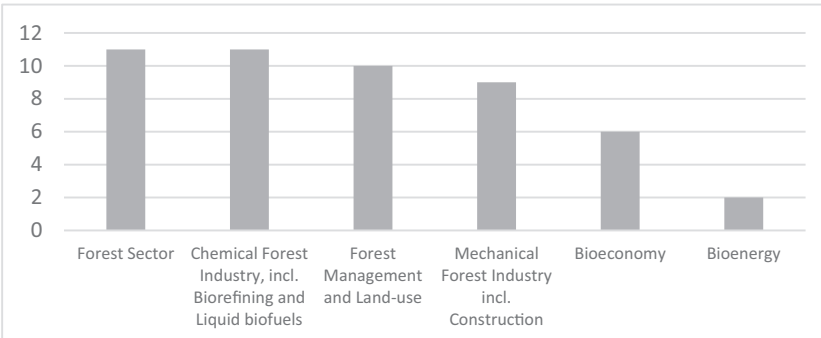

Fig. 4. Sub-sectoral scope of foresight.

sector is developing. For instance, Hagemann et al. (2016) explores alternative futures for the wood-based bioeconomy, identifying factors shaping its future course, and Hurmekoski et al. (2019) elicit expert views on long-term critical changes in the sector and analyse how these views relate to the understanding of the bioeconomy.

The smallest identified sub-sector, bioenergy ($n = 2$) consists of only two papers, both prospecting the future of solid wood based energy. Mäkelä et al. (2020) examines conceptions related to alternative futures for the use of woodchips as an energy source in Finland and Qu et al. (2010) examines the current situation of the forest bio-energy development in China and whether there is potential in terms of expert views and policies. This might be due to the research on bioenergy having been more of the quantitative outlook type than qualitative. For instance, Santos et al. (2019) identified the dimensions most considered within the bioenergy literature as costs, raw material availability and energy potential that are more quantitative dimensions and usually approached using models rather than qualitative methods.

3.3. Types of methods used

In terms of the four foresight attributes in Popper (2008), the data was distributed relatively equally among creativity, expertise, evidence and interaction (see Fig. 5), largely because the Delphi approach is the most common method, which can be seen as a combination of all the attributes. As a matter of fact, only one article by Olsmats and Kaivo-oja (2014) employed participatory workshops as their method.[1] However, the degree of interaction and the range of involvement of stakeholders can vary from "passive participation, cooperation, consultation, collaboration, and collective action" throughout the participatory studies (Sandker et al., 2008). Hence, there is no universal definition of what counts as participatory research.

While the degree of interaction does not necessarily equate to participation and vice versa, four studies (Carlsson et al., 2015; de Bruin et al., 2017; Sandström et al., 2016; Wallin et al., 2016) were stated as being participatory in showing engagement beyond business-as-usual, but their approaches and methods vary. Carlsson et al. (2015) used scenarios, de Bruin et al. (2017) scenarios and backcasting, Sandström et al. (2016) adopted participatory backcasting and Wallin et al. (2016) used the Critical Utopian Action Research method. Interestingly, three of these studies (de Bruin et al., 2017; Sandström et al., 2016; Wallin et al., 2016) do nominate workshops as a means of data collection.

3.4. Frequency and applications of individual methods

Delphi was most frequently nominated method, 49% ($n = 24$) of the articles using it as a standalone or part of the method mix, followed by interviews 16% ($n = 8$), backcasting 14% ($n = 7$) and scenarios 14% (n = 7). However, the distinction between the data collection and method selected can be difficult in many cases, since the data can be collected by multiple means that could qualify as methods themselves.

[1] In this study, the definition of 'participatory foresight' is adopted from Nikolova (2014), taking into account agents that are traditionally considered 'external' in foresight efforts or individuals who may not have specific expertise in some areas but are affected by decisions made for the future. Further, Nikolova (2014, p.4) defines participatory foresight as "aiming at wider inclusion of experts, citizens, stakeholders or nongovernmental activists, in the process of anticipating and planning the future".

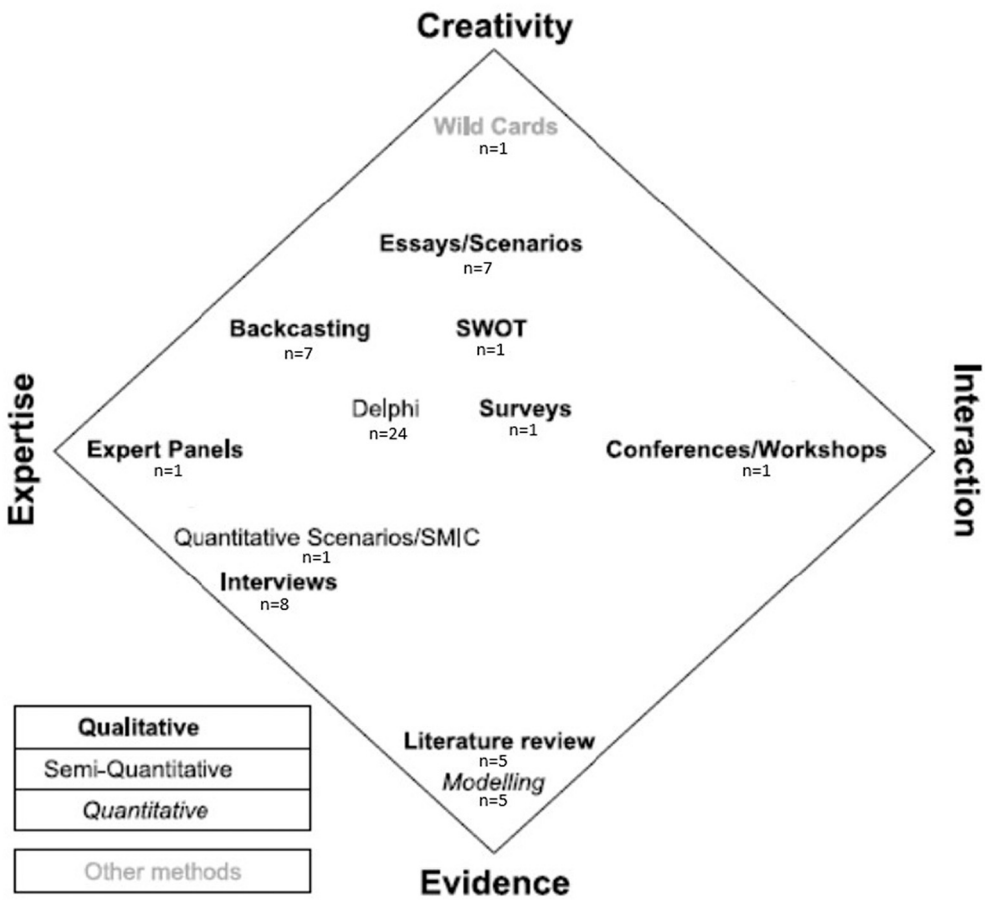

Fig. 5. Methods used in the FBS context (Adapted from Popper, 2008).

Table 2
Frequency of methods used by sub-sectors.

Method	Sub-sector					
	Forest Sector	Forest Management and Land-use	Chemical Forest Industry, incl. Biorefining and Liquid biofuels	Mechanical Forest Industry incl. Construction	Bioeconomy	Bioenergy
Delphi	2	3	8	8	2	1
Interviews	4	1	2	1		
Scenarios	2	2		2	1	
Backcasting	3	2		2		
Simulation	3			2		
Literature review	3	1		1		
NA			1		1	
Multi-level perspectives (MLP)					1	1
Innovation diffusion analysis				2		
Case study	1	1				
Comparative analysis				1		
Expert panels				1		
Focus groups			1			
Frame analysis	1					
Future visions					1	
Goal programming		1				
Quantitative scenarios	1					
Resource matrix	1					
Survey				1		
SWOT			1			
Technological innovation systems (TIS) framework			1			
The participatory action research model (CUAR)		1				
Weak signals					1	
Wild cards					1	
Workshop			1			

Popper (2008) classifies the relative frequency of foresight methods in three categories; *widely used*, *commonly used* and *less frequently used*; where the most frequently used individual methods are *literature reviews*, *expert panels* and *scenarios* in respective order according to their popularity. Compared to Popper's (2008) data and relative classification of frequency of methods used in general foresight, Delphi panels and interviews are *commonly used* and backcasting is in the *less used* category. The second most frequently used method, interviews, was never mentioned as a standalone, but was always part of multiple methods. In the Popper's (2008) analysis Delphi was identified as ninth frequent, backcasting as seventeenth frequent and interviews as eight most frequently applied method.

Regarding to the sub-sectors, the Delphi was the most frequently employed method, either as a standalone method or part of the method-mix. It was divided in to research on the chemical forest industry (n = 8), in the mechanical forest industry (n = 8), in the forest management and land-use ($n = 3$) and the bioeconomy (n = 2) sub-sectors (Table 2). In the studies focusing on the forest sector, interviews ($n = 4$) was the most frequently employed method and in the bioenergy sub-sector, both the Delphi ($n = 1$) and Multi-level perspectives ($n = 1$) were named once.

The Delphi method has been developed to solve complex, multifaceted problems with no clear history or data. Delphi also strives to determine problems interrelate and what future implications the problems at hand could possibly involve. It is used for emerging issues in particular, where neither statistical nor modelling options are applicable. It is also good for reaching groups of experts with different backgrounds aiming for consensus (e.g., van de Linde and van der Duin, 2011) or dissensus (e.g., Zimmermann et al., 2012). Hence, Delphi is nowadays widely used for different issues and could be considered a quite general method (Devaney and Henchion, 2018a; Linstone and Turoff, 1975; Popper, 2008; Rowe and Wright, 1999). In the data Delphi was explicitly named as aiming for consensus less frequently ($n = 3$) compared to dissensus ($n = 9$). In one paper, consensus and dissensus were both nominated and in most of the papers the aim was not explicitly stated ($n = 10$).

In our sample (Table 3.), Delphi has been used for a variety of purposes, such as *to analyse* the industry development from the perspective of environmental regulation effectiveness (Korhonen et al., 2015); *to assess* the current situation of the forest bio-energy development in China (Qu et al., 2010), factors influencing the biorefinery transition in the European pulp and paper industry (Brunnhofer et al., 2020); *to prioritise* value chain opportunities for the Irish bioeconomy (Devaney and Henchion, 2018b); *to compare* the roundwood supply potential of different forest management practices with respect to the development opportunities for regional forest industries under different sets of future market conditions (Lehtonen and Tykkyläinen, 2014); *to explore* the current forest industry's change features, necessary resources and management for the biorefining business in Scandinavia and North America (Näyhä and Pesonen, 2014).

According to the data, the Delphi approach has been used frequently for identification of emerging issues; for instance, *to identify* the impacts of forest management alternatives and forest characteristics on the preservation of biodiversity and habitats (Filyushkina et al., 2018). Other applications include identifying measures for meeting green building targets through wood construction (Hurmekoski et al., 2018b), the main industry- and company-level factors most likely to influence the bioenergy sector and its value-creation potential, and future corporate roles in it (Pätäri, 2010), external drivers and exploring consequent alternative expert-based scenarios for the sawmilling sector (Packalen et al., 2017), factors shaping the future competitiveness of wooden multi-story construction (Toppinen et al., 2019), and the main drivers influencing the economic development of the Norwegian forest sector (Trömborg et al., 2020).

In our data, backcasting was the third most frequently used method ($n = 7$), behind the interviews ($n = 8$), either as standalone or part of the method mix. According to Dreborg (1996, p.814), backcasting can be

Table 3
Examples of applied methods and outputs.

Application	Method		
	Delphi	Backcasting	Scenarios
to analyse	- the industry development from the perspective of environmental regulation effectiveness (Korhonen et al., 2015)		- possible future developments in global forest-product markets and discuss the overall implications of these developments for the Swedish forest sector (Jonsson, 2011)
to assess	- the current situation of the forest bio-energy development in China (Qu et al., 2010); - factors influencing the biorefinery transition in the European pulp and paper industry (Brunnhofer et al., 2020)		- the potential of scenario development as a tool for participatory planning by combining scientific and stakeholder knowledge for analysing the future of a forest landscape (Carlsson et al., 2015) - possible changes in the operational environment of construction and the implications of the changes in the competitive position of wooden multi-storey construction (Hurmekoski et al., 2015) - sawmill managers expectations of how key factors developed up to 2020 (Sjølie et al., 2015)
to compare	- the roundwood supply potential of different forest management practices with respect to the development opportunities for regional forest industries under different sets of future market conditions (Lehtonen and Tykkyläinen, 2014)	- visions of the future forest use among stakeholder groups by highlighting contemporary trajectories and identifying changes conceived as desirable in terms of similarities and differences (Sandström et al., 2016)	
to explore	- the current forest industry's change features, necessary resources and management for the biorefining business in Scandinavia and North America (Näyhä and Pesonen, 2014)	- transition of Finnish FBS companies to new business models and the whole Finnish FBS sector in terms of how FBS companies define their ideal future states and related business models for the year 2030 (Näyhä, 2020b)	- alternative futures for the wood-based bioeconomy, and identifying what influence factors have a key role in shaping its future course (Hagemann et al., 2016)
to identify	- the impacts of forest management alternatives and		

(*continued on next page*)

Table 3 (*continued*)

Application	Method		
	Delphi	Backcasting	Scenarios
	forest characteristics on the preservation of biodiversity and habitats (Filyushkina et al., 2018) - measures for meeting green building targets through wood construction (Hurmekoski et al., 2018b) - the main industry- and company-level factors most likely to influence the bioenergy sector and its value-creation potential, and future corporate roles in it (Pätäri, 2010) - external drivers and exploring consequent alternative expert-based scenarios for the sawmilling sector (Packalen et al., 2017) - factors shaping the future competitiveness of wooden multi-story construction (Toppinen et al., 2019) - the main drivers that influence the economic development of the Norwegian forest sector (Trömborg et al., 2020)		
to prioritize	- value chain opportunities for the Irish bioeconomy (Devaney and Henchion, 2018b)		

used "on long-term complex issues, involving many aspects of society as well as technological innovations and change." and is therefore applied currently to a range of issues. Backcasting is a planning method providing insights from the future and connecting them to the present. Backcasting was developed initially in understanding how far desirable futures can be achieved and undesirable futures avoided in the complex environment where interactions with humans and the surrounding world do exist. The essence of backcasting is therefore determining how desirable futures could be achieved instead of what future options are likely to happen. In other words, the essence of backcasting is not to evaluate likelihood of a particular future but the feasibility of an alternative future image. Hence, backcasting is also inherently normative and design-oriented (Quist, 2007; Quist and Vergragt, 2006; Robinson, 1990; Vergragt and Quist, 2011).

Thus backcasting can be seen as a normative scenario approach. The process of backcasting starts from the point where an issue and anticipated end result is defined clearly and the steps necessary to achieve the desired result identified, i.e., what is required to achieve the set goal under the given system conditions (Dreborg, 1996).

In our data set, backcasting has been applied, for example, *to exploring* the transition of Finnish FBS companies to new business models from the company point of view as well as from the whole Finnish FBS sector in terms of how FBS companies define their ideal future states and related business models for the year 2030 (Näyhä, 2020b). Other uses include *comparing* visions of future forest use among stakeholder groups by highlighting contemporary trajectories and identifying changes conceived as desirable in terms of similarities and differences (Sandström et al., 2016).

Other frequently used methods include scenarios and scenario analysis (n = 7) that are applied as standalones or part of the method mix; for instance, *to assess* the potential of scenario development as a tool for participatory planning by combining scientific and stakeholder knowledge for analysing the future of a forest landscape (Carlsson et al., 2015), and possible changes in the operational environment of construction and the implications of the changes in the competitive position of wooden multi-storey construction (Hurmekoski et al., 2015), *to explore* alternative futures for the wood-based bioeconomy, and *to identify* what influence factors have a key role in shaping its future course (Hagemann et al., 2016), and *to analyse* possible future developments in global forest-product markets and discuss the overall implications of these developments for the Swedish forest sector (Jonsson, 2011). In addition, Sjølie et al. (2015) has combined quantitative scenarios analysis with interviews to assess sawmill managers' expectations of how key factors developed up to 2020.

Other examples of less frequently used methods consist of multi-level perspectives ($n = 2$) to analyse the transition pathway towards a bio-based economy using transition theory, and to identify the reasons for the slow transition (Vandermeulen et al., 2012). A case study approach (n = 2) has been used to address knowledge gaps on whether policy actors learn when they are thinking, debating and shaping the 'forest futures' they want to achieve or avoid. The relevant questions include the extent to which current beliefs, values, worldviews, and conflict structures projected onto the future. What are their impacts on policy learning today? (Sotirov et al., 2017). Other examples include frame analysis ($n = 1$) to examine how key actors perceive the future of the forest sector, how they position themselves in relation to climate, energy and demography related trends (Lindahl and Westholm, 2012).

3.5. Triangulation of methods

As already illustrated, the use of multiple methods is a common approach in a foresight process. Although only a single method is reported in the majority of articles ($n = 26$), it is almost equally common ($n = 21$) to utilize multiple methods, as illustrated by Table 4. However, this is based on the explicitly reported use of methodology in the articles, and in reality, drawing a strict classification is more difficult. Many of the methods used are already intrinsically a combination or a process of using multiple methods.

3.6. Objectives of foresight

The objectives of foresight were grouped endogenously under the categories '*Drivers and Trends*', '*Management of Change*' and '*Visioning*' (Tables 5. and 6.). Although the identification of objectives did not follow any specific framework, the groups identified are somewhat aligned with Voros's (2003) generic foresight framework steps '*analysis*', '*interpretation*' and '*prospection*' in that order, and the publications analysed thus include elements of the steps of the generic foresight process to some degree. Borderline cases were discussed among the authors. Moreover, it must be acknowledged that a great majority of the publications represent characteristics from all groups. In borderline cases, the allocation was made emphasising the strongest characteristics of a publication.

Within the '*Drivers and Trends*' group, the research objective is to identify and define macro-level factors affecting an organisation or sector. In other words, this group consists of publications that focus on external drivers (categorized, for example, according to PESTEL) largely beyond the control of an individual organisation without elements of an

Table 4
Frequency of methods combined (adopted from Popper, 2008).

	Delphi	Interviews	Backcasting	Scenarios	Literature review	Simulation	Case study	Innovation diffusion analysis	Comparative analysis	Expert panels	Focus groups	Future visions	Goal programming	Quantitative scenarios	Resource matrix	Survey	SWOT	Weak signals	Wild cards	Workshop
Delphi		3	2	1	1	4		1	1	1					1	1	1			
Interviews	3		1	1	3					1				1						
Backcasting	2	1		1	1	2		1	1				1			1				
Scenarios	1	1	1					1		1										
Literature review	1	3	1			1	1	1	1							1				
Simulation	4		2		1			1	1						1	1				
Case study					1															
Innovation diffusion analysis	1		1	1	1	1			1							1				
Comparative analysis	1			1	1	1		1								1				
Expert panels	1	1		1																
Focus groups																				1
Future visions																		1	1	
Goal programming			1																	
Quantitative scenarios		1																		
Resource matrix	1					1														
Survey	1		1		1	1		1	1											
SWOT	1																			
Weak signals												1							1	
Wild cards												1						1		
Workshop											1									

In our data set, the most common combinations use Delphi with simulation (n = 4), Delphi with interviews (n = 3), Delphi with backcasting (n = 2) and backcasting with simulation (n = 2). Further, in some cases, data collection and preparatory processes might have included steps that could be considered as a method alone, e.g., interviews are done in order to prepare a Delphi study, but these are excluded if not explicitly stated as having been used. The most frequent number in the data on combined methods is two ($n = 17$) but the range is all the way up seven ($n = 1$) combined in single study.

Table 5
Foresight objectives, presented as number of occurrences and proportions of all articles in the sample.

Sub-sector	Objective			n
	Identifying Drivers and Trends	Management of Change	Visioning	
Forest Sector	2	7	2	11
Chemical Forest Industry, incl. Biorefining and Liquid biofuels	2	9	0	11
Forest Management and Land-use	1	3	6	10
Mechanical Forest Industry incl. Construction	4	5	0	9
Bioeconomy	2	2	2	6
Bioenergy	0	1	1	2
n	11	27	11	

adaptive approach.

The '*Management of Change*' group consists of papers clearly focused on the managerial perspective, defining adaptive actions or the processes of an organisation or sector. Within this group, assumptions are either based on existing analysis of an operational environment or a study may have elements of operational environment analysis, but the emphasis is on issues an organisation or sector has control over. Further, actions and analysis needed for successful transition, change or future, externally or internally are also included within this group; e.g., other impact analyses or scenarios where the result is intended to initiate an action.

Publications within the '*Visioning*' category were selected applying Bezold's (2009 p.83) visionary scenario definition that it "explores a future where a critical mass of stakeholders successfully pursed visionary strategies, the results or outcomes of pursuing these visionary strategies and the path to that visionary outcome." In this category, publications focus on 'common visions', finding compromises within or between interest groups, defining generic long-term roadmaps or the ambitions of a sector. A common denominator for this group is that the publications lack an active participation element, i.e., the objective of articles is not necessarily to identify any specific measures to prepare for identified futures, in contrast to the management of change group.

The data was split into major groups based on the objective of foresight, 'Identifying Drivers and Trends' ($n = 11$), 'Management of Change' ($n = 27$) and 'Visioning' ($n = 11$), as shown in Table 5.

Articles in the *Drivers and Trends* category (n = 11) were identified in all other subsectors except bioenergy. The group typically consists of papers dealing with forest management and the land-use sector;

identifying which global trends are likely to influence future Swedish forest use in significant ways (Beland Lindahl and Westholm, 2011); to identify threats and opportunities that global megaforces cause for the business environment and sustainability-related investments in the chemical forest industry context (Pätäri et al., 2016); and the operating environment of Finnish sawmills in the mechanical forest sector analysed using both quantitative and qualitative methods (Nuutinen et al., 2009). Identifying Drivers and Trends has seemingly been more popular in the mechanical forest industry ($n = 4$) than others, the forest sector (n = 2), chemical industry (n = 2) and forest management (n = 1).

Table 6
Foresight objectives and sub-sectors of all articles in the sample.

Sub-sector	Objective		
	Drivers and Trends	Management of Change	Visioning
Forest Sector	- Jonsson (2011) - Trömborg et al. (2020)	- Dufva and Ahlqvist (2015b) - Hurmekoski et al. (2018a) - Keskitalo et al. (2011) - Lehtonen and Tykkyläinen (2014) - Näyhä (2020b) - Sjølie et al. (2015) - Sjølie et al. (2016)	- de Bruin et al., 2017 - Lindahl and Westholm, 2012
Forest Management and Land-use	- Beland Lindahl and Westholm (2011)	- Egan and Jones (1997) - Filyushkina et al. (2018) - Masse et al. (2014)	- Carlsson et al. (2015) - Corrigan and Nieuwenhuis (2019) - Hengeveld et al. (2017) - Sandström et al. (2016) - Sotirov et al. (2017) - Wallin et al. (2016)
Chemical Forest Industry, incl. Biorefining and Liquid biofuels	- Näyhä and Pesonen (2012) - Pätäri et al. (2016)	- Brunnhofer et al. (2020) - Giurca and Späth (2017) - Korhonen et al. (2015) - Näyhä and Pesonen (2014) - Olsmats and Kaivo-oja (2014) - Pätäri (2010) - Pätäri et al. (2011) - Stern et al. (2012) - Toppinen et al. (2017)	
Mechanical Forest Industry incl. Construction	- Hurmekoski et al. (2015) - Nuutinen et al. (2009) - Packalen et al. (2017) - Toppinen et al. (2018)	- Herbohn et al. (1999) - Hurmekoski and Sjølie (2018) - Hurmekoski et al. (2018b) - Russell et al. (1993) - Toppinen et al. (2019)	
Bioeconomy	- Hagemann et al. (2016) - Hurmekoski et al. (2019)	- Devaney and Henchion (2018b) - Vandermeulen et al. (2012)	- Devaney and Henchion (2018a) - Grebyuk and Ravin (2017)
Bioenergy		- Qu et al. (2010)	- Mäkelä et al. (2020)

The *Management of Change* ($n = 27$) of change objective was identified in every sub-sector (Table 6.). It was also clearly the most common objective of foresight compared to the other two objectives. In the *forest sector* group, the objectives were evaluating the effectiveness of various policy recommendations in the future of the Norwegian forest sector (Sjølie et al., 2016); in forest management and land-use to gather relevant knowledge on the future deployment of short-rotation intensive culture of willow in Canada (Masse et al., 2014); in the chemical forest industry context to understand the specific features of the biorefinery innovation system and contextualise it in a broader landscape of competing technologies, as well as market and policy structures, in Germany (Giurca and Späth, 2017); in the mechanical forest industry context to analyse the potential of introducing new tree species for furniture industry use (Russell et al., 1993); and to assesses and prioritise value chain opportunities for the Irish bioeconomy (Devaney and Henchion, 2018b). The use of a management of change objective in the chemical forest industry was obviously most the common form of foresight objective ($n = 9$) in the FBS context, followed by the forest sector in general ($n = 7$). Adaptive objectives are also used in the mechanical forest industry ($n = 5$) and to a lesser extent in forest management ($n = 3$), bioeconomy (n = 2) and bioenergy (n = 1).

Visioning ($n = 11$) was interestingly identified as an objective in all others, except the chemical and mechanical forest industry sectors (Table 6.). In the general forest sector the visioning objective has been used to combine various stakeholder expectations to draft robust forest strategies, for example (de Bruin et al., 2017); in forest management and land-use to develop land-use policy scenarios in a participatory manner with stakeholders and assess their feasibility to see long-term impacts (Corrigan and Nieuwenhuis, 2019); in bioeconomy to define broad national strategies for research priorities (Grebenyuk and Ravin, 2017), and in the bioenergy sector how, if at all, the future of woodchip use in Finland may be changed by regime actors and for what reasons (Mäkelä et al., 2020). Visioning as a foresight objective is clearly most frequent in forest management and the land-use sector ($n = 6$), followed by the forest sector in general (n = 2), bioeconomy (n = 2) and bioenergy (n = 1).

In addition to the classification of objectives, the data includes several publications focused on method development (de Bruin et al., 2017; Devaney and Henchion, 2018a; Dufva and Ahlqvist, 2015; Hengeveld et al., 2017; and Hurmekoski and Sjølie, 2018), i.e., testing, development, and assessment of the suitability of a method. These publications were included where the methodological focus was built primarily on FBS related case studies. These publications were included: research on dynamic of elements in foresight to create future knowledge through a case study renewing the local Australian forest industry in the face of global competition (Management of Change) (Dufva and Ahlqvist, 2015b); and development of a framework to identify and take better into account diverse objectives for forest-use (Visions) (Hengeveld et al., 2017).

Interestingly, the adaptive approach, *Management of Change*, seems to be especially popular among the chemical forest industry and general forest sector. Perhaps this reflects the ongoing transformation, such as decline in communication papers and shifts in global economies and pulp and paper production (Hetemäki and Hurmekoski, 2016), and yet indicates the expectations wood-based materials are facing in terms of replacing fossil materials (Arasto et al., 2021). Similarly, communal, far-reaching *Visions* appeared to be applied especially in the forest management and land use studies context. This might be due to the increased understanding of ecosystem services and the emerging interest of the topic in the science community (Carmen et al., 2018) as well as increased understanding of the need for interdisciplinary solutions in natural resources management such as nature-based solutions (Nesshöver et al., 2017).

3.7. Potential knowledge gaps based on the literature review

In the FBS context, most of the articles seemingly concern the sector as a whole or a subsector, e.g., the pulp and paper industry or mechanical forest industry, and therefore the foresight perspective tends to be rather top-down. Apparently, the foresight literature in the FBS context from an organisation point of view or in an organisation seems to be limited. However, it is noteworthy that the data was collected from peer-reviewed journals and therefore all articles analysed are 'for business' cf. foresight 'in business', which is conducted inside the organisation the foresight concerns (Cuhls and Johnston, 2006).

A few articles have a relatively strong managerial perspective; e.g., Hurmekoski et al. (2018a) concentrates on how emerging wood-based products could compensate for the foreseen decline in graphic paper markets in four major forest industry countries: USA, Canada, Sweden, and Finland; Lehtonen and Tykkyläinen (2014) investigates how uneven-aged forest management practice could supply roundwood under different demand conditions, and Nuutinen et al. (2009) analyses the operating environment of Finnish sawmills partly from an organisational perspective. Yet, in all these studies the whole sector has been used as a level of analysis. In addition, Näyhä (2020b) sets out to understand how FBS companies define their ideal future states and related business models for the year 2030. Overall, the chemical forest industry and the mechanical forest industry sub-sectors had seemingly more managerial characteristics compared to other sub-sectors. Managerial implications are also apparent, either for a reason or as a result, in the selected methods. In these sub-sectors more foresight has been carried out by using methods, such as Delphi (Fig. 5.) leaning towards expertise, compared to other subsectors (Table 2.).

Nuutinen et al., (2009 p.32) even comments that "Futures studies in the forest sector are often too general to focus on this particular segment of forest industry; for example, there is no study in which the factors of production would be integrated with the future product and customer structure in global markets. Clearly, there is a demand for research where the future of the operating environment is analysed in the context of marketing, processing and procurement processes." Our analysis shows that these foresight activities on different segments might be better covered currently, but there is still a clear lack of research and knowledge on more explicit use and applications of corporate perspective. These type of information and practices would be useful from the perspective of company management in the FBS. Consequently, the aim of foresight is to support management in understanding the future's uncertainties and create opportunities to influence the future (Hines and Gold, 2015; Vecchiato and Roveda, 2010).

Another apparent deficiency is the degree of participatory and interactive approaches. While it might not always be justified to involve a wide range of stakeholders in the foresight process, this seems to be less common the further down the value-chain a foresight practice takes place. Surprisingly, the most active participation in foresight has been executed in the forest management and land-use sector. The analysis suggests that participatory approaches seems to be valued in situations where the risk of conflicting interests is increased (Carlsson et al., 2015; Sandström et al., 2016; Wallin et al., 2016), especially in terms of competing land-use. However, no article was found that stated the participatory approach in its wider sense clearly, intentionally engaging stakeholders outside of 'business-as-usual' (Nikolova, 2014).

As Näyhä (2020a) argued, the current FBS management has challenges in understanding future generations' preferences and yet it is expected that the need for cross-sector collaboration will increase within the FBS (Toppinen et al., 2017). It is rather surprising to see how much the participatory element is lacking. As Kaivo-oja (2017) emphasizes, it is actually humans that create the markets, networks and others crowds where products and technologies are consumed and future-oriented qualitative analyses are only as strong as their link to social understanding. Hence, in this light the current level of stakeholder inclusion cannot be fully justified. Successful, more sustainable transition and increased value-creation calls for improved triangulation in terms of more extensive inclusion of stakeholders (external and internal) (Kaivo-oja, 2017), beyond what can be considered 'business-as-usual' (Nikolova, 2014).

4. Conclusions

This review set out to systematically survey the research on foresight in the FBS with an emphasis on qualitative approaches. We were able to form an overview of existing research on the topic with the 49 articles analysed through five research questions, and categorize existing literature on the topic based on the key objectives and outcome. We also aimed to identify commonalities and differences in this literature and recognize potential avenues for further research, bringing in more flexible aspects to complement quantitative future-oriented studies.

The main findings are that the forest-based sector foresight literature with a qualitative approach could be classified into three types of study based on their objectives and types of output (Table 6.): *Identifying Drivers and Trends*, *Management of Change*, and *Visioning*. Based on the analysis, the focus has been predominantly on adaptive approaches (*Management of Change*). The sub-sectoral coverage of foresight literature in the FBS context is quite evenly distributed, no single sector standing out. Despite this, the analysis reveals that the academic research on foresight in the context of FBS is significantly sector focused and company perspectives are lacking in the existing literature with a few exceptions.

According to our review, the qualitative foresight approach in the FBS has increased in the 2010s, but not substantially. It is also clear that the research on foresight in this context is carried out predominantly in the export-driven Nordic countries and is dominated by the use of the Delphi method. The analysis also indicates that the foresight activities the literature describes are relatively well balanced in terms of attributes (*creativity, expertise, evidence* and *interaction* (Fig. 5.). This might be due to the Delphi method being relatively balanced in terms of attributes.

The review points out a number of knowledge gaps. First, the existing scientific foresight literature in the FBS context is rather top-down and largely overlooks the micro level. In terms of the transition the FBS is undergoing, this top-down view poses the risk of ignoring the role of companies forming the drivers of transition and adaptation strategies. Nevertheless, the scope of this review was more general than just corporate foresight (see section 1.3), no indication was noticeable that organisation level approaches have been used in the FBS apart from a few nods in that direction. This is particularly interesting in the context, the basic decision-making unit usually being an organization and the data indicating that the most common objective of foresight is adaptation and managing uncertainty. However, as has already been discussed, company level foresight is often done *in business* and hence is rarely publicly available. This should not limit considering the organisation level, which can be analysed in the context of foresight *for business*, e.g., in the peer-reviewed literature.

As far as we know, there are no studies dealing with how FBS companies are preparing for the future, what kind of foresight practices are used and how systematic the preparation process is. Hence, one area for future research would be to understand the level of future-preparedness within the FBS, and overall, more information on corporate foresight means and its potential in the FBS is needed. This would also put more emphasis on the practical use of strategic foresight. It would be intriguing to capture more of this point of view in to the ongoing academic discussion related to the FBS and foresight. To understand, for instance, are companies, also beyond the multi-nationals, aware of and able to capture assumed benefits of foresight. Would the FBS perceive added value of qualitative approach foresight in ongoing sector transformation, e.g. in adaptation, risk management, competitiveness and value creation, to name few.

Another knowledge gap suggested by the analysis is a rather methodological one. Despite the current foresight activities being relatively

well balanced in terms of attributes (Fig. 5.) there are slight biases towards expertise, neglecting participation. Notably, the participatory element of foresight is almost non-existent beyond the forest management and land-use sector. Further down the value chains, heavier reliance on expert perceptions might be justified in some cases, but this also raises the question of experts, especially in the face of the bioeconomy breaking sectorial boundaries. In particular, how the right experts for the future might be chosen can be explored comprehensively. And whose futures do the studies then explore?

Therefore another proposed pathway for further research is participatory foresight, between companies and stakeholders, beyond 'business-as-usual' and its potential to help achieve sustainable transitions. Could participatory foresight improve shared value creation and societal business models? Improving the interdisciplinary understanding about sources of future uncertainty helps managers to make more informed decisions and develop the potential of businesses in the face of the rapidly-changing environment.

This systematic review also has its limitations, which stem from the size of data and availability of future-oriented articles in the FBS context. Some of the search terms might also cause some imbalance in the representation of methods, since search words included methods such as Delphi and Backcasting. This was because the terminology does not seem to be established enough and many terms such as "future studies" do cause an excess of search results.

We hope this review will provide a clearer picture of what the state-of-the-art of foresight in the context of FBS is. This is especially helpful, considering this academic field is not fully established and organized in terms of concepts and terminology, while the academic field of foresight in the context of FBS is even more novel and disorganized despite the increasing interest of the topic. We hope this overview will also provide more holistic understanding of objectives and the possible applications of foresight practices, as well as further developing foresight practices in a direction that would benefit managers, organisations and the FBS sector to an even greater extent in decision-making and shaping its future.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests.

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Appendix A. Search string

"bioeconomy" OR"bio-economy" OR"bioenergy" OR"cellulose" OR"cellulose-based" OR"forest business" OR"forest cluster" OR"forest company" OR"forest firm" OR"forest industry" OR"forest industry companies" OR"forest product" OR"forest products industries" OR"forest sector" OR"forest-based" OR"lignin" OR"lumber" OR"mechanical forest industry" OR"new forest products" OR"paper company" OR"paper industry" OR"pulp and paper industry" OR"pulp industry" OR"sawmill" OR"sawmill industry" OR"spin-off" OR"start-up" OR"timber" OR"timber industry" OR"timber-based industries" OR"timber-processing industries" OR"wood industries" OR"wood products industry" OR"wood-based industry" OR"woodchips" OR"wood-chips" OR"wood-manufacturing" OR"wood-processing industry" OR"wood-products industry" OR"wood-using industry" OR"woodworking industry" AND "alternative PRE/0 futures" OR"backcasting" OR"black PRE/0 swan" OR"corporate PRE/0 foresight" OR"Delphi" OR"desired PRE/0 futures" OR"environmental PRE/0 scanning" OR"foresight" OR"futures image" OR"futures PRE/0 scenario" OR"futures PRE/0 studies" OR"futurology" OR"horizon PRE/0 scanning" OR"morphological PRE/0 analysis" OR"open PRE/0 foresight" OR"outlook PRE/0 study" OR"possible PRE/0 futures" OR"preferred PRE/0 futures" OR"probable PRE/0 futures" OR"scenario PRE/0 planning" OR"strategic PRE/0 foresight" OR"strategic PRE/0 planning" OR"weak PRE/0 signal" OR"wild PRE/0 card".

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