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journal homepage: www.elsevier.com/locate/forpolTowards sustainability? Forest-based circular bioeconomy business models in Finnish SMEs[☆]Dalia D'Amato^{a,b,*}, Simo Veijonaho^a, Anne Toppinen^{a,b}^a Faculty of Agriculture and Forestry, Dept. of Forest Sciences, University of Helsinki, Finland^b Helsinki Institute of Sustainability Science, Finland

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ABSTRACT

In line with the Sustainable Development Goals of the UN 2030 Agenda, the circular bioeconomy concept is gaining greater political momentum and research interest. A circular bioeconomy implies a more efficient resource management of bio-based renewable resources by integrating circular economy principles into the bioeconomy. These ideas have been well received at industry level since they are deemed to foster cost reductions, innovation and competitiveness. While recent scientific literature has dwelt on sustainability-related circular business models, empirical research on company-level implementation is only just emerging. Our study contributes to addressing this research lacuna by seeking answers to two questions: 1. How do small and medium-sized enterprises (SMEs) propose, create and deliver, and capture value through circular bioeconomy business models?; and 2. What are the business challenges and opportunities related to the operationalization of such business models? To this end, we employed content analysis on interview data gathered from managers in Finnish SME companies from the field of packaging, textiles, composite materials, cosmetics and pharmaceutical products. We outlined the main business model archetypes, and identified the key characteristics that enable value capture and delivery for various stakeholders. The contribution of this study is duly two-fold. From the perspective of a theoretical contribution, we expand and refine the conceptualization of sustainable circular bioeconomy and related business models. In addition, based on our findings, we provide insights and recommendations for researchers and policy-makers to advance the sustainability transition to a circular bioeconomy in the context of the forest-based industry, and for the management of SMEs to reflect on company viability and growth.

1. Introduction

The present overuse of the Earth's natural resources and overstepping of planetary boundaries, coupled with the predicted population growth (Rockstrom et al., 2009; Steffen et al., 2015) call for fundamental changes to our consumption and production system (MA, 2005). The circular economy and bioeconomy are two sustainability-oriented concepts aimed at transforming the current linear, fossil-based economy towards a more efficient, waste- recycling one, with the bioeconomy being based on the use of renewable biological resources. Such ideas are currently being strongly advocated at policy level internationally and in Europe (EC, 2015, 2012), while they are also well received at industry level, since they are deemed to foster cost reductions, innovation and competitiveness (Guenster et al., 2011; Korhonen

et al., 2018a).

The Nordic countries are considered to hold great potential for the implementation of the circular bioeconomy, especially in conjunction with the much-needed renewal of the forest sector (Roos and Stendahl, 2015; Winkel, 2017; Wolfslehner et al., 2016; Pätäri et al., 2016), where structural changes are causing turbulence in the global markets, and the need to renew the traditional management culture is a key challenge (Hansen, 2016; Korhonen et al., 2018a). Consequently, several large multinational companies are integrating circular and bioeconomy elements into their business portfolio, operations and sustainability practices, while small and medium-sized enterprises (SMEs) are emerging with new sustainability-driven business models.

Documenting and analyzing these phenomena is particularly important, as industries and business organizations are expected to be

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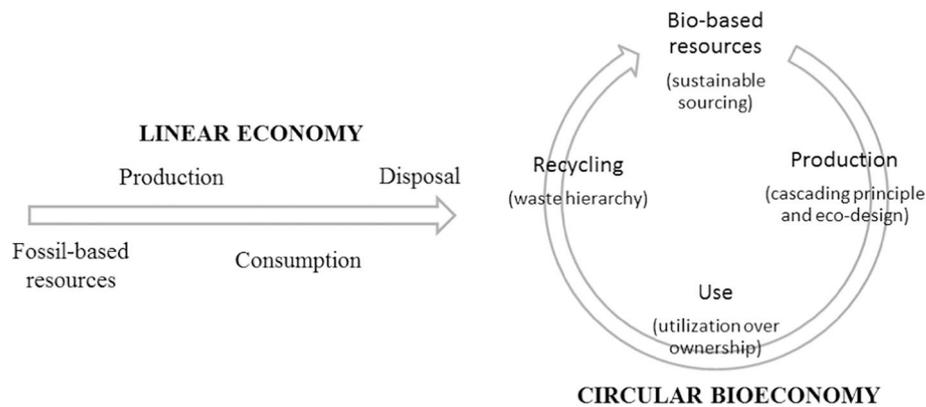


Fig. 1. The circular bioeconomy as a sustainability transition away from a linear economy (own representation).

pivotal to the development of both the circular economy and the bioeconomy, and to contribute to the Sustainable Development Goals of the UN 2030 Agenda. However, empirical research on circular or bioeconomy business models remains scarce (Bocken et al., 2017; Reim et al., 2017), especially in the context of the forest sector. Analysis of the overall circular bioeconomy concept is also in its infancy (Bezama, 2016; Ciccamese et al., 2014; D'Amato et al., 2017).

Our study contributes to addressing the above-mentioned research lacuna by analyzing the circular bioeconomy business models of small and medium enterprises (SMEs). The research examines the following questions: 1. How do SMEs propose, create and deliver, and capture value (both for the company and for other societal stakeholders) through circular bioeconomy business models? and 2. What are the business challenges and opportunities related to the operationalization of such business models? In order to address these questions, we employ content analysis on interview data concerning managers from selected SMEs who have been identified as operating with circular or bio-based business models.

The rest of the article is structured as follows. Section 2 expands on the existing conceptualization of a sustainable circular bioeconomy, as well as of circular bioeconomy business models. Sections 3 and 4 provide a description of the method and results, respectively. Section 5 offers an interpretation of the findings in relation to the conceptual frameworks provided in Section 2, and in the light of recent literature. Finally, Section 6 presents conclusions on how the findings can offer insights and recommendations for researchers and policy-makers to advance the sustainability transition to a circular bioeconomy in the context of the forest-based industry. It also highlights the implications for the management of SMEs in terms of company viability and growth.

2. Conceptual background

2.1. The circular bioeconomy

Pursuing Sustainable Development Goals calls for adopting radical innovations and changes in the current economic model and production-consumption systems, with the private sector playing a key role in this process (El-Chichakli et al., 2016; Lieder and Rashid, 2016). The bioeconomy and the circular economy are advocated at policy, research and industry levels to hold potential for contributing to such sustainability transformations. The circular economy, rooted in five decades of ideas regarding industrial ecology and metabolism, is focused on improving the efficiency and recycling capacity of the current consumption-production system through input reductions, eco-design, improved practices, waste reuse and recycling (Kirchherr et al., 2017; Korhonen et al., 2018b; Murray et al., 2015; the Ellen MacArthur Foundation, 2012). The more recent idea of the bioeconomy promotes the transition from fossil-based industrial inputs to biomass-based ones, emphasizing the sustainable use of renewable resources (Kleinschmit et al., 2014;

Korhonen et al. 2018c; Pfau et al., 2014; Priefer et al., 2017; Pülzl et al., 2014; Winkel, 2017). Technological innovation, the development of regional capacities and knowledge centres, as well as industrial collaboration and symbiosis are central forces for both circular economy and bioeconomy development. For example, in Finland much of the expectation concerning circular and bioeconomy strategies has been connected with the forest sector and wood, with less emphasis on clean technology, resource efficiency and recycling (Antikainen et al., 2017).

The concrete contribution of the circular economy and the bioeconomy to resolving sustainability challenges, however, is still widely debated (D'Amato et al., 2017; Kröger and Raitio, 2017). The circular economy is limited in that it is oriented towards economic and certain environmental gains, but does not refer to the social dimension to any significant extent. Furthermore, some scholars have argued that efficiency gains may often simply lead to rebound effects in terms of increasing production and consumption, thereby failing to achieve net environmental benefits (Korhonen and Seager, 2008). Criticisms of the bioeconomy emphasize its inability to deliver environmental benefits solely through the substitution of fossil-based resources with bio-based ones, if the latter are not managed sustainably (Mustalahti, 2017; Pfau et al., 2014). In fact, both the circular economy and the bioeconomy are resource-oriented concepts which still largely fail to address synergies and conflicts with broader ecological processes and ecosystem services (D'Amato et al., 2017). For instance, bioeconomy-led strategies aimed at 'intensifying biomass harvest may conflict with multiple other social economic and environmental functions of forests' (Eyvindson et al., 2018, p. 119).

The emerging circular bioeconomy concept aims to address the limitations of the individual concepts. The circular bioeconomy is not simply about adopting circularity principles, such as biomass cascading, waste hierarchy and efficiency in the use of biomass resources (Bezama, 2016; Ciccamese et al., 2014; Vis et al., 2016); it is described as 'more than bioeconomy or circular economy alone' (Hetemäki, 2017, p. 14). In this paper, we advocate that a circular bioeconomy should also include elements such as sustainable sourcing of biomass, as well as aim at utilization rather than ownership (e.g. sharing, rental, pay-per-use) (Fig. 1).

Agriculture, forestry, and associated industries are pivotal in the implementation of the circular bioeconomy (Ollikainen, 2014; Roos and Stendahl, 2015). In addition to providing renewable biological resources, these sectors are also fertile ground for the required research and innovation processes (Bugge et al., 2016; Kleinschmit et al., 2014; Pfau et al., 2014). In Finland, high expectations are imposed upon the renewal of the forest sector to enable the transition to a circular bioeconomy (Antikainen et al., 2017).

2.2. Sustainable business models

Although well-recognized, there is no complete agreement among

scholars on the definition of business model (DaSilva and Trkman, 2014; Osterwalder and Pigneur, 2005; Richardson, 2008; Teece, 2010; Wirtz et al., 2015). According to Richardson (2008) and Zott et al. (2011), the business model has emerged as a new unit of analysis at the company level, and includes the following components: value proposition; creation and delivery; and capture. The value proposition addresses the needs of target customers through product/service offerings and through customer relationships, and also represents the competitive advantage of a company. Value creation and delivery refers to the company's resources, technologies and relationship network, which enable a competitive advantage and create customer value. Value capture regards the cost structure and revenue streams. Every company operates a business model, whether knowingly or unknowingly, by converting customers' needs to create a competitive advantage through utilizing its strategic resources (Teece, 2010). Moreover, according to Teece (2010), choosing the right business model is critical for enabling innovation and supporting customer value creation.

Innovative business models are deemed to be key enablers in transformations towards more sustainable production-consumption systems (Antikainen et al., 2017; Hetemäki, 2017). A sustainability-oriented business model should ideally point to sustainable value for customers and all other stakeholders, create and deliver this value, and 'capture economic value while maintaining or regenerating natural, social, and economic capital beyond its organizational boundaries' (Schaltegger et al., 2016, p. 6). In other words, sustainable business models operate by aligning company and global sustainability goals (Bocken et al., 2014; Rauter et al., 2017). According to Boons and Lüdeke-Freund (2013), business value propositions can be extended to include social and ecological value, in addition to economic value. Moreover, sustainability can also be addressed at value creation and delivery levels in terms of using renewable resources, developing sustainable technological innovations, engaging with responsible suppliers/contracts, and driving more sustainable consumption. Finally, sustainable value capture implies the fair redistribution of income and expenditure between parties (Boons and Lüdeke-Freund, 2013).

In their well-known paper, Bocken et al. (2014) proposed eight archetypes of sustainable business, based on three main business model innovations: technological, social, and organizational. According to Bocken et al. (2014), technological innovation includes archetypes based on efficiency, waste recycling and use of renewables. Social innovation-based archetypes are related to greener immaterial values and attitudes: promoting the use of products/services rather than ownership, adopting higher environmental and social stewardship roles, and encouraging sufficiency and frugality in consumption. Archetypes based on an innovative organizational structure entail repurposing business for society/the environment, and developing scale-up solutions that have social or environmental benefits Bocken et al. (2014).

Based on Bocken et al. (2014), we have created a conceptual framework to aid the interpretation of our findings (Fig. 2). Our framework was developed in an iterative process by confronting the theory with the data.

3. Data and methods

Given the contemporary nature of the phenomenon under study, we conducted qualitative interviews to record the knowledge and experience of relevant informants, not least because qualitative research is a well-established tool in management and business administration research (Gummesson, 1991). Semi-structured interviews enable an in-depth dialogue that can eventually be re-directed towards emerging or new topics (Kvale and Brinkmann, 2009).

Finland, with its recent circular and bioeconomy strategies (Sitra, 2016; Finnish Bioeconomy Strategy, 2014), provides an interesting empirical context for the study. Businesses of different sizes and segments are promoting new growth in sustainability-driven business models, despite implementation challenges (Antikainen et al., 2017).

The data derive from interview material with managers of relevant companies. Based on purposeful sampling (Maxwell, 2009), we selected 13 small and medium-sized companies from the website of a government-funded platform promoting the export of Finnish circular bioeconomy companies (FinPro, 2018).¹ The selected companies deal with products or services based on forest biomass resources, including solutions for new or hybrid materials and textiles, packaging, cosmetics, and pharmaceutical products. We purposefully excluded companies dealing with the production of bioenergy and fuels, as we wanted to focus on higher value-added products and services.

Between February and April 2018, eight companies agreed to participate in the study. Interviews were conducted in Finnish, face-to-face or by phone, and with owners or managers responsible for company strategy or corporate sustainability (Table 1, denoted with letters A to H). Based on the assessed data saturation and methodological considerations (Marshall et al., 2013), we considered the data to be sufficient for our purposes.

The questionnaire design was based on the conceptualization of a sustainable business model by Bocken et al. (2014), including value proposition, value creation and delivery, and value capture. A semi-structured questionnaire including open-ended questions (see Appendix) was sent to the interviewees in advance, along with the rationale for the study. Questions 1–5 concerned the company's background information and the interviewee's familiarity with the circular bioeconomy concept. Questions 6–8 were about the company business model value proposition, while questions 9–10 focused on value creation and delivery, and 11–13 inquired about value capture.

The interviews were recorded, transcribed and then translated from Finnish into English. Notes were also taken to support the audio data. A preliminary analysis was conducted during the data collection in order to determine saturation and to modify the interview strategy according to the emerging data (Maxwell, 2009). The transcribed data were analyzed by means of coding using Atlas v 7.5.18 software. 'The goal (of coding) is to develop categories that capture the fullness of the experience and actions studied' (Kvale and Brinkmann, 2009, p. 202). The literature was used to support the development of codes and the interpretation of results through an abductive, iterative process. However, predetermined literature-driven coding categories included: i. the eight business models identified by Bocken et al. (2014); and ii. the individual components of the business model, namely value proposition, value creation and delivery, and value capture (Fig. 2).

During the analysis, codes were identified and attributed to a certain archetype, as well as to one of the components of the business models: value proposition, value creation and delivery, or value capture. For instance, the code 'Using waste as raw material' was attributed to the archetype 'Creating value from waste', and simultaneously to 'value creation and delivery'. This way, it was possible to identify the components of the business model for each company, as well as the overall business model archetypes. In addition, more codes were created to identify company motivations and growth strategy, as well as future challenges and opportunities for circular businesses.

The following measures were adopted to ensure validity and reliability. The questionnaire was pre-tested on four researchers with expertise in business models and circular bioeconomy. Anonymity was guaranteed to the interviewees and the company they work for. The interview data were triangulated with other sources, such as information found on the company website.

¹ In 2018, the government-funded organization 'FinPro', promoting Finnish trade, was merged with 'Tekes', the Finnish Funding Agency for Innovation, to create 'Business Finland'.

	Value proposition (What?)	Value creation & delivery (How?)	Value capture (For whom?)
Maximising material and energy productivity and efficiency	Products/services using less resources, generating less waste and emissions	Adopting more efficient and safe production processes	Reducing costs, minimising environmental impact
Creating value from waste	Turning waste into higher value products/services	Using recycled materials, ensuring recyclability of products/services	Reducing costs, as well as waste and virgin material use
Substituting with renewables and natural processes	Products/services using bio-based renewable materials and energy	Adopting innovative production processes based on bio-based materials	Commercializing new products/services, reducing environmental impact
Delivering functionality, rather than ownership	Shifting from a consumer to a user logic	Enabling products/services reuse and repairing	Commercializing user-based solutions, reducing materiality, enabling consumer access to expensive products/services
Adopting a stewardship role	Providing access to more sustainable alternatives	Seeking resource co-management and transparency in supply chains	Securing a customer base by leveraging stewardship of social and ecological systems
Encouraging sufficiency	Products/services reducing demand or consumption	Promoting responsible consumption and frugality (e.g. by ensuring products/services longevity)	Encouraging premium pricing, customer loyalty, increased market share, reducing materiality
Re-purposing the business for society/the environment	Prioritizing social and environmental benefits along with economic profit	Developing hybrid businesses, cooperatives	Establishing a new business while securing livelihoods and/or supporting natural systems
Developing scale-up solutions	Expanding products/services commercialization	Developing adequate infrastructure and partnering with additional operators	Sharing and promoting sustainability-oriented businesses by e.g. licensing

Fig. 2. Sustainable business model archetypes (own representation, based on Bocken et al., 2014).

Table 1
Selected companies, main business areas and role of interviewees.

Company	Product/service	Interviewee
A	Transparent packaging material for food industry	Chief Executive Officer (CEO)
B	Water-resistant composite material for household fixtures	Chief Executive Officer (CEO)
C	Medical device/cosmetic product	Chief Executive Officer (CEO)
D	Staple fibre for textile and non-woven industries	Chief Executive Officer (CEO)
E	Packaging material for packaging industry	Chief Technological Officer (CTO)
F	Biotech enzymes and services for customer	Chief Executive Officer (CEO)
G	Ideas and patents for pharmaceutical products	Chief Executive Officer (CEO)
H	Composite material for kitchen utensils and dinnerware	Export manager

4. Results

4.1. Company background and motivations

All of the companies were established during the second half of the 2000s, with the exception of company H. They were small companies, typically with less than 10 employees, and with an annual turnover ranging from zero to a few million euros. When it came to corporate vision, company A was the only one whose motivation was to fill a gap in market demand, while the others were primarily interested in commercializing new technologies and products. In fact, the general lack of market investigation prior to commercialization in Finnish businesses was underlined by the CEO of company A: *'As we are so engineering-minded in Finland, we develop great solutions for problems that no one has'*.

Some of the company owners or managers had themselves been involved in the original development of the idea or technology behind their business. For example, the CEO of company D had been in charge of the technology development for staple fibres at a national research institute. As he was not satisfied with the pace of the progress being made, he started his own company. In another case, the chairman of the board of company C established the company after observing nurses using tree resins to cure wounds when he was a medical doctor.

Based on managerial interviews, the companies did not have a strong perception with regard to operating under a circular bioeconomy (or sustainability) framework; some were simply established to pursue

new business opportunities: *'The biggest headache for companies is how to make products that someone wants to buy, and then the team sells them to the best of their ability. But no entrepreneur in the world has started out thinking, "Let's make something related to the circular bioeconomy", and then thought about what that might be. It just doesn't happen that way'* (CEO, Company B). Others emphasized that sustainability is part of their vision, and they are working to improve that aspect.

In the following subsections (4.2 and 4.3), we address research questions 1 and 2 (cf. Introduction), respectively.

4.2. Diversity of business models

The most common archetypes found in the companies were 'Substituting with renewables and natural processes', 'Maximizing material and energy efficiency', 'Developing scale-up solutions' and 'Adopting a stewardship role' (Fig. 3, Table 2). At the other end of the continuum, archetypes such as 'Delivering functionality, rather than ownership' and 'Re-purposing the business for society/the environment' were never recorded.

The archetype 'Maximizing material and energy efficiency' was realized by the selected companies through the offer of environmentally and/or socially more sustainable products and services, created through technological improvements (reducing inputs and outputs). This contributed to reducing costs (e.g. less raw material needed, lower transport costs) and reducing the environmental impact. The following

	Value proposition (What?)	Value creation & delivery (How?)	Value capture (For whom?)
Maximising material and energy productivity and efficiency	Products/services using less resources, generating less waste and emissions	Adopting more efficient and safe production processes	Reducing costs, minimising environmental impact
Creating value from waste	Turning waste into higher value products/services	Using recycled materials, ensuring recyclability of products/services	Reducing costs, as well as waste and virgin material use
Substituting with renewables and natural processes	Products/services using bio-based renewable materials and energy	Adopting innovative production processes based on bio-based materials	Commercializing new products/services, reducing environmental impact
Delivering functionality, rather than ownership	Shifting from a consumer to a user logic	Enabling products/services reuse and repairing	Commercializing user-based solutions, reducing materiality, enabling consumer access to expensive products/services
Adopting a stewardship role	Providing access to more sustainable alternatives	Seeking resource co-management and transparency in supply chains	Securing a customer base by leveraging stewardship of social and ecological systems
Encouraging sufficiency	Products/services reducing demand or consumption	Promoting responsible consumption and frugality (e.g. by ensuring products/services longevity)	Encouraging premium pricing, customer loyalty, increased market share, reducing materiality
Re-purposing the business for society/the environment	Prioritizing social and environmental benefits along with economic profit	Developing hybrid businesses, cooperatives	Establishing a new business while securing livelihoods and/or supporting natural systems
Developing scale-up solutions	Expanding products/services commercialization	Developing adequate infrastructure and partnering with additional operators	Sharing and promoting sustainability-oriented businesses by e.g. licensing

Fig. 3. Archetypes found in the dataset (dark grey = most common archetypes; light grey = less common archetypes; white = archetypes not recorded).

quotes exemplify this: ‘The density is about 1 and the ceramics have something like 2.2, so it is lighter, almost half of its specific weight. There will be some benefits related to logistics, but that was never ... it is just great that it happens to be so’ (CEO, Company B); ‘Using the cup consumes more energy than the actual production or disposal. The emissions from production are zero’ (Export manager, Company H).

The archetype ‘Creating value from waste’ was operationalized by recycling raw materials and waste in production, possibly by turning them into higher-value products or services. As one CEO remarked: ‘[...] products with more value are developed. For instance, we use sawdust here as a raw material, which is a by-product of the spruce saw mill. We make a product from it with quite high added value’ (CEO, Company F). This archetype is also about enhancing the recyclability of products/services, for instance by ensuring compatibility with existing recycling systems/infrastructures or by ensuring biodegradability: ‘The food packaging industry doesn’t have this kind of product, which is made from renewable raw materials, and which would also be biodegradable’ (CEO, Company A); ‘But we know that our production technology enables the use of a wider range of raw materials compared to, for instance, traditional paper manufacturing. So this will also enable us to search for new kinds of recycled raw materials in the long term, or other kinds of natural materials’ (CEO, Company G). No particular benefit for revenues/costs was associated with this archetype, but environmental value is associated with reducing waste and not overexploiting virgin raw materials.

The archetype ‘Substituting with renewables and natural processes’ was realized by using forest-based renewable resources for production. These new raw materials can be compatible with existing production technologies or require innovations. In addition, these new products can have better or more unique qualities than existing alternatives: ‘We can create different patterns and looks for the material with wood chip fractions. And what is maybe special compared to other composite products is that the resin we are using is as clear as glass. So, in a way, the look of the material comes from the wood chips inside the composite’ (CEO, Company B); ‘Of course, this use of tree resin components is highly unique. The raw material is certainly very different’ (CEO, Company C). Value for the company was represented by revenues from new market areas and by lower costs when producing on a bigger scale. The introduction of

such new, renewable materials or production processes can imply a reduction in environmental impacts during production, and a decrease in the societal use of plastics or other non-renewable materials: ‘We were researching what kind of technology could be used to replace plastic’ (CEO, Company G).

Elements of the archetype ‘Adopting a stewardship role’ were found in the use of certified materials and the communication of life-cycle impacts to influence customers’ buying behaviour. Value was captured by the higher price resulting from branding and reducing environmental impacts during production. The following quotes from the interviews explain these processes: ‘If you look at our website, we try to openly tell the story of what we are doing and what it is based on. And explicitly mention how sustainable the whole production chain is, how ethical it is and what kind of social influences it can have. That it is at the core of our thinking’ (CEO, Company D); ‘[...] actually I have this carbon footprint study open here, which reports on our best-selling product if you would like to know more about that. It is equal to 1.2 kilograms of potatoes or driving 2 kilometres on a highway with a diesel car. It’s kind of “cradle to gate”, and the calculations also include usage, in fact’ (Export manager, Company H); ‘This brand idea means that consumers are ready to pay some extra for the environmental benefit’ (CEO, Company A).

The archetype ‘Encouraging sufficiency’ concerned products designed to be more durable: ‘[...] that is why we have tried to position our product in this (shopping) bag field as an environmentally-friendly, multi-use bag, which can be used multiple times – the bag facilitates this because it lasts so well’ (CEO, Company G); ‘It is light and durable, so the idea is that it will last for a long time and there will be no need to get rid of it’ (Export manager, Company H).

Finally, the archetype ‘Developing scale-up solutions’ was operationalized by the companies by designing products or ideas that could be sold on or exported, for instance through licensing or developing new value chains with partners. Compatibility with existing production infrastructure also emerged as a feature: ‘Our materials can be processed with existing technological processes, so we do not have to build a plant’ (CEO, Company A). This archetype would result in cost reduction and price competitiveness, as well as a competitive advantage and revenue for partners: ‘For instance, if we license the use of our material to plastic

Table 2
Business models executed by the selected companies.

Company	Value proposition	Value creation and delivery	Value capture	Overall business model (archetypes)
A	Biodegradable, wood-based packaging solutions, compatible with existing production infrastructure, possibility to scale up	Resources: renewable, certified raw materials Technology: new production technology, but compatible with existing facilities Partners: research and production outsourced, developing new value chains with stakeholders	For company: Higher price due to branding, lower costs from outsourcing services, no need for big investments in new production infrastructure, lower raw material costs for big volumes For others: competitive advantage for partners, additional incomes for industrial partners, influencing customers' buying behaviour, reducing plastics, no competition with food systems	Maximizing material and energy efficiency; creating value from waste; substituting with renewables and natural processes; adopting a stewardship role; developing scale-up solutions
B	Design product made out of wood composite which can be recycled as energy.	Resources: unique look from wood-based (renewable) raw material Technology: new production technology, with less inputs and outputs needed and safer processes Partners: commercial suppliers provide tailor-made solutions, strategic partners in production	For company: higher price due to branding/design, income from new market area/wider product selection, lower transport cost due to light weight For others: Reducing production inputs and outputs, transport emission due to lighter weight	Maximizing material and energy efficiency; creating value from waste; substituting with renewables and natural processes
C	Pharmaceutical from tree resin.	Resources: small amount of raw material needed, uncommon and renewable source Technology: own production facilities Partners: co-operation with research institutes/universities and international industrial companies, outsourcing raw material supply and other services	For company: cheaper than alternative, incomes from export and from unique qualities, small transport costs due to small quantities of raw material needed For others: better product compared to other natural alternatives, less user costs associated with medical treatments, improving users' quality of life, no major environmental impact from harvesting	Maximizing material and energy efficiency; creating value from waste; substituting with renewables and natural processes; adopting a stewardship role
D	Wood-based textile fibre, compatible with existing production infrastructures, possibility to scale up	Resources: renewable Technology: own production technology, with less inputs and outputs needed and safer processes Partners: procurement from existing raw material suppliers, co-developed solutions with partners, and cooperation with international industrial actors.	For company: price competitive, higher price due to branding For others: additional incomes for industrial partners, reducing environmental impact in production.	Maximizing material and energy efficiency; substituting with renewables and natural processes; adopting a stewardship role; developing scale-up solutions
E	Industrial enzymes and supporting services for bio-industry, which can be quickly commercialized.	Resources: renewable Technology: own technology outsourcing production plans Partners: co-operation with research institutes/universities and international industrial companies, outsourcing services, developing new value chains with stakeholders	For company: income from new market areas, fast idea commercialization and lower costs from outsourcing services For others: restoring industry-related jobs in the west, reducing environmental impact in production, broader social benefits from environmental health	Maximizing material and energy efficiency; substituting with renewables and natural processes; adopting a stewardship role; developing scale-up solutions
F	Licensing ideas for wood-based pharmaceuticals.	Resources: small amount of raw material needed, sourced from industrial by-product Partners: Co-operation with international industrial companies, outsourcing services including R&D.	For company: incomes from idea, not product, lower costs from outsourcing services For others: improving users' quality of life, no big social and environmental impact from harvesting, turning industrial by-products into higher value products.	Maximizing material and energy efficiency; substituting with renewables and natural processes; adopting a stewardship role; developing scale-up solutions
G	Wood-based, durable packaging solutions, compatible with existing production and recycling infrastructures, possibility to scale up, same functionality with improved qualities	Resources: various kinds of renewable raw materials, potentially also from industrial by-products Technology: new technology compatible with many kinds of renewable raw materials, developing new value chains with stakeholders Partners: co-operation with international industrial companies, outsourcing services, sustainability-oriented partner selection, procurement from existing raw material supplier	For company: incomes from unique qualities, lower costs due to fewer raw materials needed and from outsourcing services For others: reducing environmental impact in production and reducing societal use of plastic	Maximizing material and energy efficiency; creating value from waste; substituting with renewables and natural processes; adopting a stewardship role; encouraging sufficiency; developing scale-up solutions
H	Design product made out of wood composite, which is durable and can be upcycled; same functionality with improved qualities	Resources: renewable Technology: own production facilities, with less inputs and outputs needed and safer processes Partners: procurement from existing raw material suppliers, co-developed solutions with partners	For company: incomes from export, from unique qualities and from wide product selection For others: reducing environmental impact in production, turning industrial by-products into higher value products	Maximizing material and energy efficiency; creating value from waste; substituting with renewables and natural processes; adopting a stewardship role; encouraging sufficiency

producers so that it means new business for them, they will undoubtedly gain new customers, or new business from existing customers, or retain their current customers, who would otherwise change to someone else that has the eco-product' (CEO, Company A); 'And then, of course, the only goal is that it would become, and must be capable of becoming, price competitive in large volumes compared to the existing alternatives' (CEO, Company D).

4.3. Future business and sustainability challenges and opportunities

The interviewees also brought up the challenges that lie ahead for circular bioeconomy SMEs. For example, a potential problem was identified in establishing *co-operation and dialogue* with key partners and operators in the value chain, as well as with other companies operating in the circular bioeconomy network. In relation to this, the CEO of company F explained that there was a need to concretize the circular bioeconomy network into a practical platform to really promote commercialization and the entry into international markets: 'How can you support the export activities of those companies from a business perspective if one is producing acoustic solutions for office spaces, another is selling foods to the medicine and food industry, and a third is doing something else? [...] although we are under this kind of circular bioeconomy strategic umbrella, there should be an understanding of the business areas these companies are working in. Because it is the only way to capture those customers and really commercialize the products, because in reality there is no circular bioeconomy business'.

Lack of *capital and financial resources* was also mentioned as a challenge by three interviewees, and as stated by the CTO of Company E: 'The challenge is how to raise your own capital [...] In Finland there are very few of these investors, there is very little private money moving or available at all to be directed towards these kinds of things. [...] producing bio-based products like these is still quite capital intensive. It takes time and long-term knowledge before you get things working in this sector. In the ICT sector all you need is two guys and a laptop, so they can make the capital last quite a long time. But in this sector you will get nowhere with that'. Other challenges that were mentioned were more disparate and related to legislation, market penetration, technological development or implementation, and compatibility with current infrastructures (e.g. compatibility of recycling systems).

Future opportunities can arise from the fact that new solutions and more sustainable alternatives are either required by regulations or demanded by customers, as highlighted by the CEO of company G: 'Company G's business idea started from the fact that plastic bags are being replaced in so many places. Alternatives such as paper bags have existed for a very long time, but it still creates a new gap in the market, a situation for new solutions'.

In regard to internationalization, foreseen growth strategies for the companies included creating new value chains with key partners (from suppliers to customers) and engaging with product co-creation, exporting to international markets, and licensing ideas, technology or products to other companies. Some companies were operating in, or aiming at, global markets (A, D, E, F and G), while others were seeking growth from exporting while keeping production in Finland. For instance, companies D and G had their production capacity in Finland, but were cooperating with international partners with the aim of scaling up by means of co-owned production capacity or licensing: 'We can, of course, be the fibre producer ourselves; we can license the technology to someone; or then we could aim to join forces with Company X and found a co-owned company that will produce the fibre' (CEO, Company D). Companies A and E had offshored their production abroad. Company F aimed at selling or licensing the product idea abroad, as no potential customers had been identified in Finland. Their competitive advantage, however, was embedded in the high standard of Finnish research and development: 'Finland has a reputation for research studies that can be trusted. This is not the case everywhere. We use the "proof of concept" idea to demonstrate the results of a study, which makes it more likely that the research done here will be seen as valid abroad' (CEO, Company F).

Companies B, C and H were also seeking growth abroad. For instance, company H's products were already being sold in about 30 countries.

5. Discussion

SMEs are key actors in the transition to a circular bioeconomy because of their greater flexibility, dynamism and capability of generating the required innovations, which larger companies operating in the mature forest sector are often lacking (Hansen, 2016). Our analysis confirms the diversity in sustainability-related business model archetypes among Finnish circular bioeconomy SMEs. In particular, six archetypes were identified, namely dealing with material and energy efficiency, waste valorization, use of renewable materials, environmental and social stewardship, sufficiency and frugality, and the scaling-up of sustainable solutions. Some of these archetypes were more dominant than others across companies. For instance, elements of the archetypes 'Maximizing material and energy efficiency' were mentioned by each company, while ideas related to 'Encouraging sufficiency' were found in only two companies and mainly related to product longevity. Instead, two of the archetypes proposed by Bocken et al. (2014) (Fig. 2) 'Deliver functionality rather than ownership' and 'Repurposing business for society/the environment' were completely missing.

Our findings are in line with what was previously identified in the literature, according to which circular business models tend to focus more on strategies that aim to close material loops (i.e. efficiency, waste as a resource), while there is 'a very slow uptake of "radical" forms of circular business model innovation, such as sharing models' (Bocken et al., 2017, p. 489). Other elements, such as slowing the loops (i.e. with longer-life products), have also been overlooked, as likewise observed by Bocken et al. (2017) and Merli et al. (2018). In this regard, the servitization megatrend provides an avenue for the transition towards more diverse circular bioeconomy business models, simultaneously supported by customer demand and regulatory processes (Heyes et al., 2018). These phenomena would support a circular economy through a shift from a product-oriented approach to a user-centred eco-design (Heyes et al., 2018), which could favour sharing models and other solutions to reduce material consumption (Ghisellini et al., 2016), as well as the co-creation of value from products with longer and more sustainable life cycles. The role of services has also been found to be pivotal in the development of a bioeconomy, to support business model innovation and to improve existing products and processes via servitization (Pelli et al., 2017).

In regard to value proposition, the companies analyzed in this study were found to deal with products and services related to biomaterials, biotechnology and biocompounds. While we purposefully excluded companies dealing with bioenergy and fuels, we did not record activities related to tourism or forestry, which have been mentioned by Reim et al. (2017) and Kajanus et al. (2018) among emerging forest bioeconomy-related innovations. Instead, we registered strong circularity elements, similar to those highlighted by Manninen et al. (2018), especially in regard to resource use reduction and optimization, and waste and emission reduction. Product/service features suggested by the interviewees as being important in the construction of the value proposition included design, compatibility with production and recycling systems, unique or better product quality compared to existing alternatives, and licensing or scaling-up possibilities.

Regarding value creation and delivery, various assets regarding raw materials, technological know-how and/or partnership were identified as strategic resources for the companies. Companies C and F, which dealt with pharmaceuticals, benefitted from needing only a small amount of raw material, while producing high value-added products. While all of the companies mentioned the use of forest-based renewable raw materials as a resource base, only one company was using non-virgin raw materials, while a second company speculated about development in that direction for their future production. It should be noted that this finding is to be interpreted in the context of scarcely

populated Finland, where the wood-based bioeconomy is heavily dependent on virgin fibre, despite high national paper recycling rates.

Several companies were identified as being based on some sort of innovative technological development, but compatibility with existing production/processing facilities was often an important advantage. Several managers mentioned that this new combination of resources and technology results in cleaner and safer production processes compared to the existing alternatives; in specific processes, wood-based fibre, for instance, does not require the same kind of high temperatures or chemicals as fossil-based raw materials.

Outsourcing services (including raw material procurement, research and development, production and marketing), developing new value chains with stakeholders, and co-operation with international partners and the research community were found to be particularly important to these SMEs. Regarding value creation and delivery, similar findings have emerged in previous studies. New technologies integrated with existing industrial infrastructures can support synergies in relation to 'energy and material flows as well as to know-how regarding processes', but for this potential to be realized, companies are 'dependent on strategic alliances with actors with complementary knowledge' (Mossberg et al., 2017). The importance of cultivating partnerships with suppliers (especially from the forestry-wood value chain), regulators, researchers and sustainability-oriented customers is emphasized in previous research: 'circular business model innovations are by nature networked: they require collaboration, communication, and coordination within complex networks of interdependent but independent actors/stakeholders' (Antikainen et al., 2016, p.7). Oghazi et al. (2018, p. 3) also stressed the 'close collaboration with suppliers, partners, and customers, which requires clear agreements and mutual trust'. However, other studies also suggest the need for innovation (e.g. improving circularity and logistics) and for challenging the traditional forest-sector culture (Hansen, 2016; Manninen et al., 2018; Reim et al., 2017; Korhonen et al. 2018a).

According to our analysis, strategic features associated with resources, technology and partnerships allowed companies to expand without placing an excessive burden on fixed costs, duly supporting value capture for the company. Cost reduction resulted largely from lower raw material costs (either because of large volumes processed or small amounts needed), and from outsourcing services (especially due to compatibility with existing production facilities), thereby maintaining a light company structure. Value capture benefitted from higher-priced branded products or from unique product features, lending support to business models as a source of competitive advantage (e.g. Zott et al., 2011). Other important elements were enhancing internationalization and a wider product selection. Even though the above-mentioned assets were identified as beneficial to value capture in regard to profitability, it may be too early to draw final conclusions on their relative importance for company growth and competitiveness, since all of these companies were still in a very early commercialization phase.

Previous research has suggested that the bioeconomy can help pulp and paper companies to 'move away from stagnating markets' and benefit from 'new income streams' (Reim et al., 2017, p. 777); and that cost reduction can arise, for example, from circular strategies (e.g. reductions of input resources, valorization of waste) (Ormazabal et al., 2018), even though 'special designs for reparability, durability, and upgradability might increase the initial costs of product/service development' (Oghazi et al., 2018, p. 3). Nonetheless, our study suggests, as also recorded by Reim et al. (2017), that revenues from circular bioeconomy products and services are not yet as profitable as their alternatives, and SMEs often rely heavily on public support for research and development.

Raising risk capital, concretely promoting commercialization, and exporting to international markets were among the key future challenges facing the companies interviewed for our study, in line with what has been identified in similar studies. For instance, Ormazabal

et al. (2018, p. 166) highlighted that 'hard barriers can be addressed by financial stimulation and technological modernization, as they are connected to the lack of financial resources, technology, inadequate information systems [...] and human-based barriers including 'issues like company leadership or the lack of customer interest in the environment'. The lack of financial resources is a typical phenomenon observed in the product-innovation literature as the 'Valley of Death', where resources are generally more easily found during the research and development phase compared to the commercialization phase (cf. e.g. Branscomb and Auerswald, 2002).

According to the interviewees, value capture for societal actors, other than the company itself, and for the environment, included creating a competitive advantage and additional incomes for key partners. These include, for instance, supporting job creation, improved quality of life and consumption choices for users and customers, and reduced social and environmental impact in production as well as in the total life cycle of the product/service. The existing literature proposes that the bioeconomy can potentially capture social and environmental value by reducing waste, and acknowledging ecosystem services, as well as by supporting local employment and rural development, and recreation and energy security (Reim et al., 2017). In practice, however, an important issue is the verification of the concrete realization of environmental and social value, for which Manninen et al. (2018) advocate the need for introducing a reference system. The environmental and social benefit derived from circular bioeconomy products and services could in fact be offset by rebound effects, namely excessive or incorrect use. This, in addition to verification, also calls for solutions such as customer co-creation (Antikainen et al., 2016; Oghazi et al., 2018).

It also raises the question of how the circular bioeconomy (and related business implications) connects to other key sustainability concepts, such as the green economy,² to the idea of planetary boundaries (Haffar and Searcy, 2018), to the social dimension of sustainability, and more broadly to the Sustainable Development Goals (D'Amato et al., 2017; Hetemäki, 2017). At the macro-economic level, while not conflicting with ideas such as degrowth or steady-state economy, most of the circular economy and bioeconomy literature and policies are rooted in the idea of economic growth while decoupling environmental impact (D'Amato et al., 2017; Ghisellini et al., 2016; Hobson and Lynch, 2016).

While the variety of business models observed in this study support sustainability-based value creation, they appeared to be strongly dominated by traditional practices (e.g. use of renewables, efficiency). On the other hand, more avant-gardist perspectives were missing in the business models analyzed, such as promoting frugality, reducing materiality, securing livelihoods and/or supporting natural systems. Notably, these have the potential to contribute, in addition to environmental goals, to some aspects of social sustainability that are typically under-represented in circular and often even in bioeconomy strategies. A possible explanation for the lack of more 'radical' circular bioeconomy activities is that efficiency or recycling are more directly associated with cost reductions. On the other hand, financial or strategic benefits are not so evident in the case of other solutions, such as re-thinking ownership, limiting the company size, or shifting towards alternative models, such as cooperatives, foundations and community interest companies whose primary goal is not profit maximization (Charonis, 2013). Traditional sustainability practices, however, are deemed 'insufficient in themselves to deliver the holistic changes necessary to achieve long-term social and environmental sustainability' (Bocken et al., 2014, p. 42).

² For instance, companies C and F in our study were commercializing the medicinal properties of forest products; this strongly resonates with the idea of the green economy, advocating that natural capital provides benefits (in the form of ecosystem services) for human well-being (e.g. medicinal resources).

Table 3
Relevance of findings to public policy^a, research community and company management.

Conclusions	Stakeholder relevance	Recommendation
Despite its emerging popularity at policy and industry level, the circular bioeconomy concept is still weakly recognized in the scientific literature globally, as well as by the interviewees, who did not consider the concept particularly useful for advancing their business activities	Public policy Research community	Further develop the conceptualization of the circular economy; assess implementation at business level in different sized businesses, organizational types and contexts (e.g. quantitatively-oriented analysis of business-model archetypes using representative samples)
Profitability of circular bioeconomy business is low, and businesses still rely heavily on public support for research and development. This creates a 'Valley of Death' phenomenon, implying that companies face a crisis due to scarcer financial resources during the commercialization phase	Public policy Company management Research community	Evaluate the distribution of financial support to avoid 'Valley of Death' situations Evaluate risks and adopt strategies to respond to 'Valley of Death' situations Investigate the viability of circular bioeconomy SMEs in the long term, especially after the initial development phase
Strategic assets for value creation, capture and delivery included the renewable and circular nature of the resources used, the compatibility of the technological innovation with existing production/processing facilities, and the enabling potential of key partnerships with suppliers, producers, customers and the whole innovation ecosystem	Public policy Research community Company management	Incentivize and support technological compatibility as well as partnership formation across traditional and circular bioeconomy activities. Identify key strategic resources, technology choices and partners emerging in different or larger sets of companies (cf. e.g. L\"ah\"tinen et al. 2009) Evaluate current status of own strategic assets and areas of improvement
Some social and environmental benefits for stakeholders external to the companies were identified, for instance job creation, improved quality of life and consumption choices of users and customers, as well as reduced social and environmental impact in production and in the whole life cycle of the product/service. The relative importance of such impacts remains unassessed, however.	Research community Public policy Company management	Create tools and reference systems to ensure verification and measurability of social and environmental outcomes in a comparative manner across sectors and different sized companies
The identified business models focused on traditional sustainability perspectives, such as maximizing material and energy efficiency based on the use of forest biomass-based raw materials. Diversification of business models under the circular bioeconomy framework is important for supporting sustainability goals in Finland and globally	Public policy Company management	Evaluate the conditions necessary for the more 'radical' circular bioeconomy activities, especially those promoting reduced user consumption and those directly supporting and enhancing socio-ecological systems.

^a The considerations taken up in this study may be of particular relevance for the government-funded platform 'FinPro' (re-named 'Business Finland' in 2018), which promotes the export of Finnish circular bioeconomy companies.

6. Conclusions and recommendations

Based on the analysis of interview data gathered from SME managers, this study expands and refines the conceptualization of sustainable circular bioeconomy and related business models. The results, coupled with recent literature (cf. Section 5), can provide some insights into the challenges and opportunities posed by a transition towards a circular bioeconomy, particularly in the context of the Finnish forest-based industry (Table 3).

The limitations of our results include the following. First, the concept of business models is a notion developed and proposed by academics or consultants and, as such, it does not necessarily resonate concretely within companies, especially small startups or SMEs. Second, the sample was small, and the selected companies formed a diverse group operating in different business areas, which may represent a challenge for homogeneity in terms of the unit of analysis. Due to the small size of the companies, we could only interview one representative of each company; this hampers the possibility to compare and validate information regarding the same company. Third, the companies were at a very early stage of development in their respective businesses, and hence some topics may not have matured sufficiently within company thinking. Fourth, sensitive information (e.g. regarding competitive advantage) provided by the interviewees might be partial or superficial. Finally, a minimal information loss or distortion might have occurred, despite accurate translation by a bilingual researcher, who also conducted the interviews.

Due to the above-mentioned limitations, the results cannot be generalized to a broader sample, but we considered the data sufficient for an explorative examination of an emerging phenomenon such as the one investigated in this study.

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Appendix A. Questionnaire in English

Questionnaire starts

Identifying questions:

1. When was the company established?
2. What were the initial motivations for starting the company?
3. What is the size of the company? Employees? Turnover?
4. What is your role in the company?
5. How familiar are you with the circular bioeconomy?

Open questions:

6. What kind of products/services does your company provide?
7. What are the innovative/revolutionary aspects of your company's products/services?
8. What are the competing or alternative products/services?
9. What does your company do differently in manufacturing processes and/or other operations?
10. How do your key partners support/enable your value creation? E.g. shareholders, employees, suppliers, contractors, customers, local communities and other stakeholders.
11. Please describe in what way your business model could lead to cost reduction/profit increase compared to dominant business logic (directly or indirectly)?

12. How does your company make a positive contribution to environmental and social development?
13. Where will your company be in 5 to 10 years and what business opportunities and challenges do you foresee arising from the circular bioeconomy?
14. Any other comments/ideas/opinions?

Questionnaire ends.

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