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Article

Perceptions on the Importance of Forest Sector Innovations: Biofuels, Biomaterials, or Niche Products?

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Abstract: New innovations are called for to renew the European forest sector into bioeconomy. However, little research exists on how the industry innovativeness is publicly perceived. Using data collected with an online questionnaire in four European countries, we investigate perceptions related to forest sector innovations on 13 current and new bioeconomy-related products and services. Altogether, 218 valid responses were received in 2015, and the data were analysed using descriptive statistics, performance-importance analysis, and Gartner's innovation hype cycle. Based on our results, the respondents were in the strongest agreement that the forest sector has since the year 2000 has produced innovations related to wood building systems, construction materials, and wood composites. In the next 15 years, they foresaw a decline in innovations related to biofuels and paper products. The European forest sector also has future potential in wood construction, which is likely related to international policy targets related to carbon mitigation and capture. The observed variation in perceptions among the respondents on forest sector innovativeness calls for strengthening industry R&D, as well as by improving societal awareness of ongoing innovation projects by developing better communication.

Keywords: forest bioeconomy; innovations; Austria; Finland; Germany; Slovenia; hype cycle

1. Introduction

A creative destruction is expected to take place in the forest sector with many products maturing and factors for competitiveness changing [1]. New innovations are clearly needed to renew the traditional wood, pulp, and paper industry sector into bioeconomy. According to the definition of the European Commission [2], bioeconomy constitutes " . . . the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy. Its sectors and industries have strong innovation potential due to their use of science, enabling and industrial technologies, along with local and tacit knowledge". Furthermore, the European commission blueprint [3] underlines the importance of stimulating sectoral transition with radical innovations, structural adaptation, and increasing efficiency in material and energy use towards zero-waste production to allow sustainable market growth both within and outside the EU. The bioeconomy era offers many opportunities for holistic development of the forest sector through the intelligent use of biomass, as well as through developing innovations related to the entire spectrum of forest ecosystem services [4].

Although sustainability as a transformational force in global competition in the forest sector has gained more ground [5], scientific debate about the bioeconomy and its relation to sustainability is still at an early stage [6,7]. In addition, the research field is dominated by technological orientation [6,8], lacking the capability to address critical preconditions, trade-offs, or societal/consumer benefits. A competitive bioeconomy not only needs to encompass tangible components associated with bio-resources, but also intangible components in terms of the ability to produce and process customer knowledge to ensure adaptation in the changing global economic context and meeting sustainability challenges [8,9].

Furthermore, a " ... transition described for the bioeconomy and post-carbon strategies and pathways will require system-wide changes involving society, governments and industry" [10] (p. 10462). The involvement of the forest sector at the societal level has received much less attention, although normative issues of bioeconomy have to be discussed at the societal level before or during new-product development, if bioeconomy-related inventions are to be implemented in a welfare enhancing way [11]. Importantly, understanding current perceptions on innovations is one of the key challenges that need to be overcome to reach social acceptance [12]. Conflicting issues with bioeconomy have included ethical issues with adopting new biotechnology, land use change [13], biomass use for energy, or the food-fuel debate [14,15]. Another example of potential conflicting issues can be found from the interdependencies of carbon storage and material efficiency aspects of wooden buildings [16].

Furthermore, scholars point out that more attention is needed on the European level for innovations to support better resource efficiency at the end of life, e.g., with the use of post-consumer wood waste for wood-based panels or wood pellets, utilizing pulp waste for new bioeconomy products and targeting improved efficiency processes for recycling and incineration [17]. For example, the recycling rate of non-hazardous construction and demolition waste management should be at a minimum of 70% of its weight by 2020 [18], also inducing new innovation challenges for forest sector companies processing wood products, especially for construction purposes [19].

From a business point of view, innovations are needed for the diversification of forest industry business models and product portfolios, which have previously been excluded from forest-based sector analyses and practices [20]. A recent study [21] on the development of advanced biorefinery in Sweden suggests that biorefineries could act as a platform for the revitalization of the mature pulp and paper industry. However, they felt that without the use of innovation policy instruments that create markets for renewable fuels and green chemicals, the diffusion beyond demonstration plants will be very slow. As another example, the spread of wooden multi-story construction (WMC), especially in the Nordic countries, has been claimed as the most interesting new business opportunity in the emerging forest bioeconomy [22,23].

In addition to sustainability and innovations, the third avenue of sectoral renewal can be seen to be associated with services (or servitization, i.e., integration of services and products) and the way that services enter business processes in current global value chains. Instead of thinking of the increasing role of services as a trend, it can be interpreted as an indicator of more profound changes taking place in the forest industrial production modes and in the logic of how operations are organized [24].

The perception of newly developed products and technologies is often accompanied by hype, a phase characterized by an upsurge of public attention and high rising expectations about the potential of the innovation [25]. Such hypes are, according to the Gartner hype cycle concept [26], followed by a considerable decline of attention that may be connected with disappointment of the earlier expectations. The according ups and downs of expectations have been shown to potentially have a strong impact on innovation processes [25,27].

Based on a recent literature review [28], forest industry competitiveness is increasingly connected with various types of factors related to innovation and differentiation strategies at the firm-level.

However, this report also found that cross-sectoral R&D collaboration, which is strongly advocated by national and international bioeconomy strategies, is almost completely missing in firm-level analysis of the forest sector. Overall, research on public perceptions or expectations affecting the acceptability of the forest sector innovations in Europe is very fragmented, with the exception of a recent study [29] only related to forest ecosystem services. The study by Ranacher et al. (2017) also found that public perceptions vary highly among respondents regarding how they see the level of forest sector responsibility, indicating a potential legitimacy gap and a risk of losing the social license to operate for forest sector businesses [29]. From a general perspective, scholars [30] argue that radical innovations describing creative destruction stem from institutional changes.

To contribute to the scarce literature on forest bioeconomy from an innovations perspective, we aim to investigate perceptions in four European Union member countries related to forest sector innovation and innovativeness. Our specific research questions are as follows:

1. How is the past and expected innovation performance of the forest sector perceived among our respondents?
2. How are different types of innovations perceived among our respondents?

To do this, we used data collected with an online questionnaire during May–September 2015 from four European countries and analysed it using descriptive statistics, performance-importance analysis, and the Gartner's hype cycle concept.

2. Conceptual Background

According to Schumpeter, innovation is [31] a mechanism that deploys new knowledge, technology, products, or services in the market and is, in the form of creative destruction, a necessary driver for competitiveness and economic dynamics. He defined five different types of innovation in the introduction of a new product (1), a new method of production (2), the opening of a new market (3), discovering a new input supply (4), or a change in industrial structure (5). At the company level, innovativeness can be understood either as one's ability to develop and utilize innovations or as the propensity to innovate, and deals with changes in products, services, processes, or business systems (i.e., administrational or marketing innovations). However, innovation and innovativeness are two terms that tend to be used interchangeably in both the theory and practice of forest sector innovation research, although they do not have the same meaning [32].

In our study, we approach innovations in forest bioeconomy from the viewpoint of a value-added pyramid (Figure 1) and by recognizing innovation opportunities in terms of products, production processes, services, or business models. The bottom segment of the pyramid consists of incremental improvements in traditional pulp, paper, and wood products and wood-based bioenergy. The middle section is characterized by more value-added components, which could be advanced biofuels, biomaterials, and composites, or from an organizational innovations point of view, developing new marketing channels, service enhancements, or the reduction of environmental impacts. The top of the pyramid then includes higher-value added, niche products such as highly sophisticated system solutions (for example in the new tall wooden buildings), fine chemicals, or nanocellulose. Nanocellulose is, due to its high versatility, perhaps the most interesting new niche material discussed under the umbrella of forest bioeconomy [33]. Nanocellulose has the most promising applications in light-weight fibre-based packages and composites with excellent strength properties and potentially some added functionality, the modification of rheological properties of liquids and suspensions in various industrial fields, transparent films as barrier materials, substrates for printed electronics and electronic displays, hydrogels for medical applications, and aerogels for filtration and insulation [34].

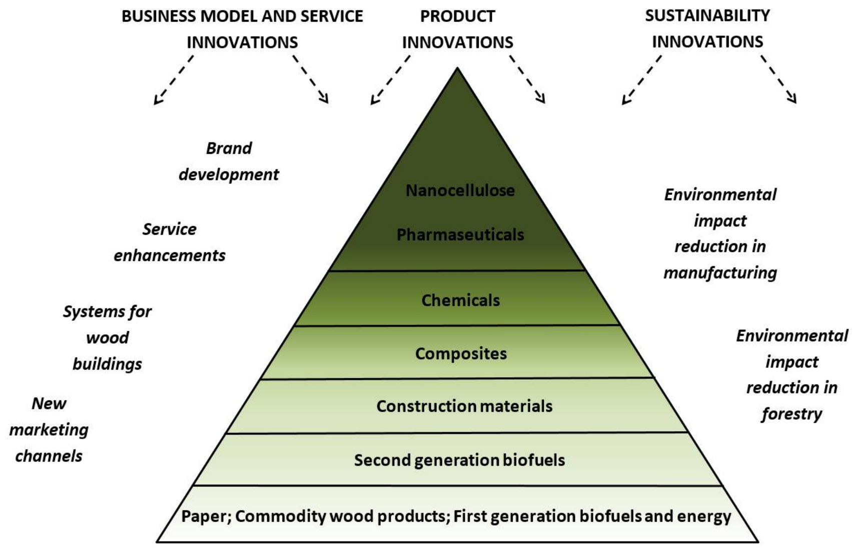

Figure 1. Classification of forest bioeconomy-related innovations using a value pyramid. Note: Due to condensing of the text, the full content of the lowest part includes pulp, paper, paperboard, commodity wood products, and first-generation biofuels and bio-based energy.

One of the core challenges in forest bioeconomy is to successfully materialize the move from bottom low added to top high value added, where volumes of products and services tend to be much smaller in terms of market demand. Scholars [35] have advocated that in future biorefineries, the economics of scope inevitably mean moving away from large-sized cost efficient processes making bulk products into more customized and innovative products and specialized uses of resources, which means changing the dominant industry logic. In order to understand this change process better, it is necessary to further elaborate on the dynamic aspects in forest-based bioeconomy innovations.

Technology hype cycle models have mainly been developed and utilized for the purpose of the early identification of new and convergent technologies and of forecasting potential social change (e.g., [27]). In particular, supported by the development of bibliometric methods, attempts to analyse hype cycles through quantitative analytical approaches and to utilize their results in forecasting (e.g., [36,37]) have been developed. Among technology cycle models, Gartner's hype cycle model [38] (see Figure 2) has become popular due to its explanatory power.

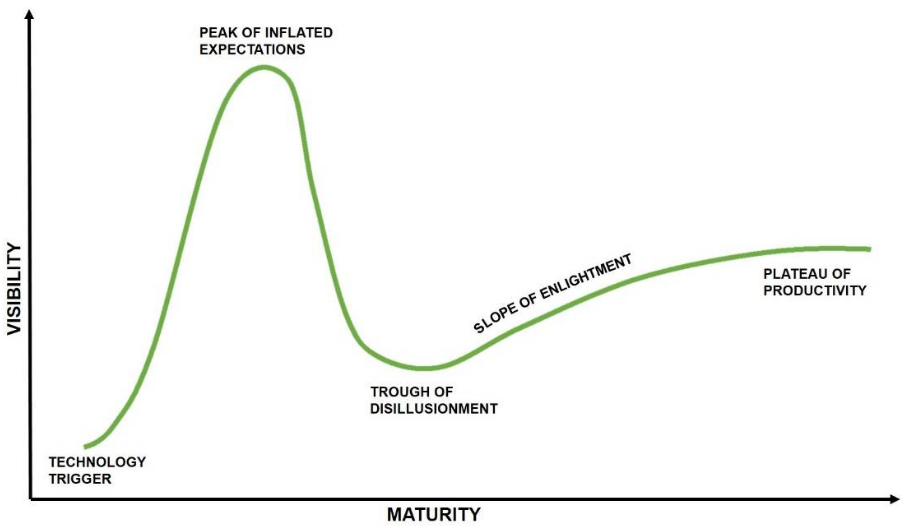

Figure 2. Gartner technology hype cycle (adapted from [38]).

Efforts to empirically analyse technology hype cycles during the early 2000s focused on stock markets and therefore failed to sufficiently account for the visibility of the technology, which is one main feature of the hype cycle [38]. Later on, the efforts to make empirical contributions to the hype cycle concept progressed by making use of indices of news reports and technology literature [39] However, "the explanatory power of such studies still remained unimpressive, due to the insufficiency of empirical analyses linked to the theories closely related to the hype cycle, such as those pertaining to product cycles or consumer behaviour" [27] (p. 82). For example, the possibility of building connections between the Gartner hype cycle model and conventional product life cycle models has been studied in an empirical case of hybrid automobiles in the U.S. [27] and energy storage technologies [40].

For the identification of the differences, the importance-satisfaction matrix, based on the quadrat analysis [41], was chosen as a useful instrument. The importance-satisfaction matrix has already been used in various fields, for example, it has been applied to the customer's perception gap on the importance and performance of 14 automotive service attributes [42] or of an organization's services [43], and has been employed to analyse the gap between customers' and managers' perception with respect to the characteristics of public transportation services [44] or the supplier's and buyer's gap on softwood lumber quality requirements [41]. In general, the matrix visually depicts customer priorities and product feature evaluations [45]. This graphical visualization and the possibility to plot both the importance and performance of various features in one grid makes it easy to interpret [41,42].

3. Material and Methods

The survey data used in this study were part of a larger European survey on perceptions of the forest sector [46]. The survey was available online and advertised via e-mail (e.g., industry e-mail lists, including different stakeholder groups, as well as forestry students), social media, and online forums, with the purpose of reaching both people involved and not involved in the forest sector. The majority of the respondents originate from four forestry rich European countries namely, Austria, Finland, Germany, and Slovenia. Thus, respondents were selected through convenience sampling aiming at as rich participation as possible. However, no conclusions can be drawn on the opinion of national populations. The data gathering was implemented during May–September 2015.

In contrast to other topics covered [29,47,48], the part of the survey reported in this paper focused on the range of forest sector innovation. For the survey, a questionnaire consisting of three modules was developed. The first module was designed to investigate how respondents perceived forest sector companies' past performance (since the year 2000) related to 13 forest-bioeconomy-innovations (wood construction materials, paper products, composite materials fabricated with wood or paper materials, nanocellulose, biofuels made from forest resources, service enhancements in forest management, production processes, material substitution with wood, developing recognized brands, developing or utilizing new marketing channels, reducing the environmental impacts of forestry, reducing the environmental impacts of processing and manufacturing, and building systems with wood). The second module was designed to measure the considered importance of the 13 forest-bioeconomy-innovations for societal and sustainable development over the next 20 years. For all cases, a five-point Likert-scale (1 = Strongly disagree, 3 = Undecided, 5 = Strongly agree), including an additional "I don't know" option, was used. In module 3, respondents were asked about how often they purchased forest sector products and services.

The questionnaire was pre-tested in native languages prior to the implementation of actual data gathering and then back translated. In all four countries, a pre-test was conducted in April 2015 (with $n = 20$) to make sure that the questions could be understood, and based on it, some changes were made to the questionnaire. In addition to inquiring about an extensive list of various potential areas of innovations, questions about the socio-demographic characteristics of the respondents were included in the fourth module (e.g., age, gender, education, residential area, employment status, and involvement in the forest sector through formal education, profession, or forest-ownership).

Altogether, 218 valid responses were received on the perceived current and future state of forest industry innovativeness using 13 forest-bioeconomy-innovations. Of the 218 respondents, 37%, 32%, 23%, and 8% were from Germany, Slovenia, Austria, and Finland, respectively. A slightly lower share were women (47.6%) and 51% were between 21 and 41 years old. Slightly over one half (53%) of the respondents stated that they lived in urban areas.

Overall, it must be stated that the sample is not representative of any of the country populations, and instead it portrays perceptions of a more limited set of persons with or without forest sector involvement, but interested in industry performance. It is assumed that some of those who participated in the survey did so for a specific reason, such as familiarity either with the topic, or the involved research institution. It likely attracted respondents interested in forestry and forest issues even when not formally involved in the sector [48]. Thus, the existence of a response bias must be considered. In order to deal with the most obvious bias in the sample, the potential sector involvement by employment, education, or ownership was considered in the survey and analysis. Due to an uneven number of respondents from the four countries, we will make no attempt to analyze country-level differences.

The following first presents the distributions of the actual questions and respondent reactions to them. The data were analysed using descriptive statistics and t-tests, as well as performance-importance analysis to investigate potential gaps, and to identify the structure of respondent expectations. After this, we dive into analysing the innovation hype curve to reflect on the previously presented model of innovation.

4. Results

4.1. Recognition and Importance of Different Innovations

Our respondents were in the strongest agreement that the forest sector has, since the year 2000, produced innovations for wood building systems, construction materials, and composites. The lowest image of innovativeness since the year 2000 was perceived to be associated with the organizational side: the development of new marketing channels and recognized brands, as well as forestry services (see Figure 3). Another area perceived as being less innovative was paper products.

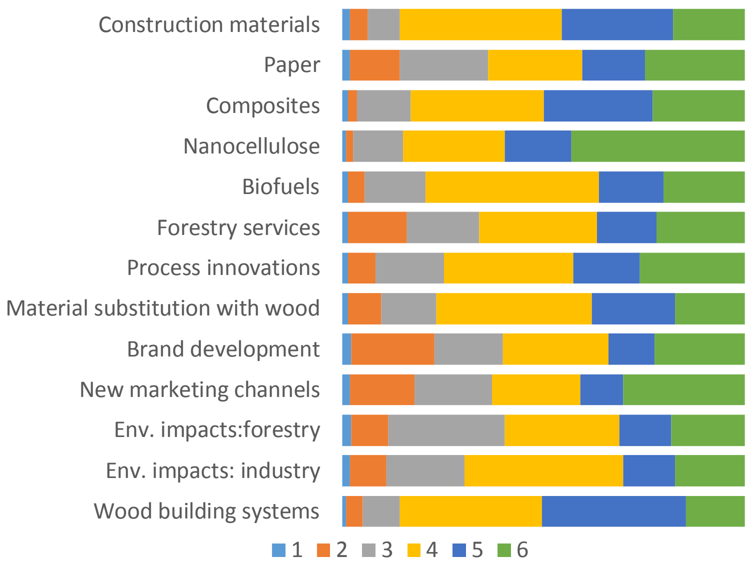

Figure 3. Respondent distribution to the statement: "Since the year 2000, forest sector companies have produced significant innovations related to . . . " (Scale from 1 = Strongly disagree, to 5 = Strongly agree, 6 = I don't know).

For the next 20 years (see Figure 4), it was perceived that the forest industry should continue to focus on wood construction-related innovation efforts. The development of wood-based biofuels and paper products gained the lowest level of support. Regarding nanocellulose, it is notable that over one-third of the respondents were incapable of evaluating past as well as future innovation activity, indicating that they lacked awareness regarding this innovative material. When comparing the mean values of respondents for past innovation performance and future expectations on innovativeness, it was evident that the respondents have higher expectations for future innovativeness, with the only exception of biofuels (significant decrease at 1% level). Other t-tests (with the exception of paper and composites) were significant and showed that respondents attributed higher values to the future than to the past.

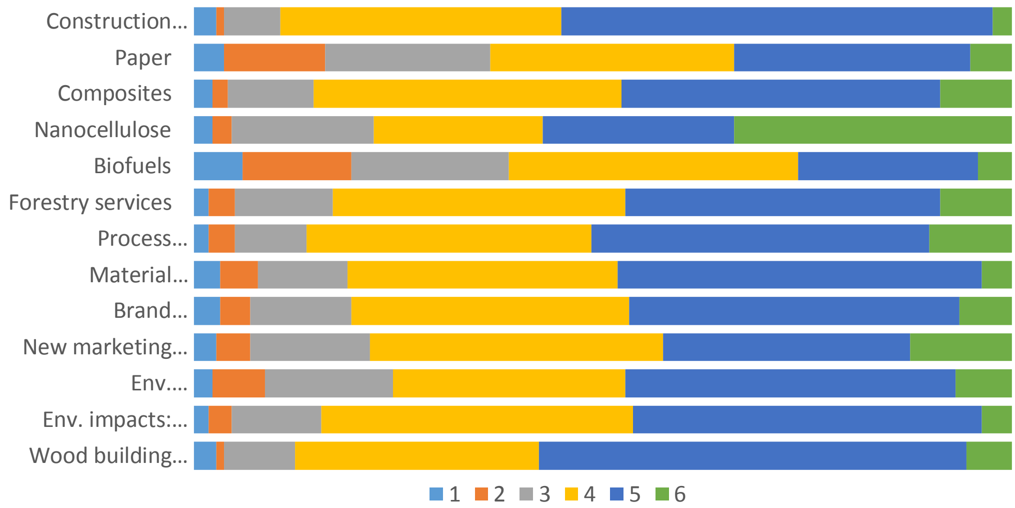

Figure 4. Respondent distribution to the statement: "For societal and sustainable development, I think the forest sector should focus their innovation efforts over the next 20 years on . . . " (Scale from 1 = Strongly disagree, to 5 = Strongly agree, 6 = I don't know).

Applying the same data to a performance importance grid (see Figure 5) using the variables of the past developments (i.e., the statement formulated as, "Since year 2000, forest sector companies have produced significant innovations related to . . . ") as performance indicators, and the variables on future requirements (i.e., the statement formulated as, "For societal and sustainable development, I think the forest sector should focus in their innovation efforts over the next 20 years on . . . ") as importance indicators, additional information can be extracted. According to Figure 5, construction materials, wood building systems, and composites can be all found in the top right quadrant of the grid. Those innovation areas can be therefore considered as top performers, and they are considered as important, as well as already successful, in terms of awareness among the respondents. However, it is important to keep in mind that all 13 items were rated as relatively important and no major differences exist.

Within all innovations covered, wood-based biofuels represent the greatest anomaly. It is the only innovation for which the future importance is perceived to be clearly lower than the performance in the past. In contrast, paper-related innovations were generally rated at a relatively low level when focusing on the past 15 years, but appeared to demonstrate a slight increase for the future. In the case of nanocellulose, the future importance and the past performance were almost equal; however, as stated before, over 30% of the respondents were not able to provide a rating in this case. Of the top performers, the smallest increase between past and future ratings was perceived among respondents in the case of wood-based composites.

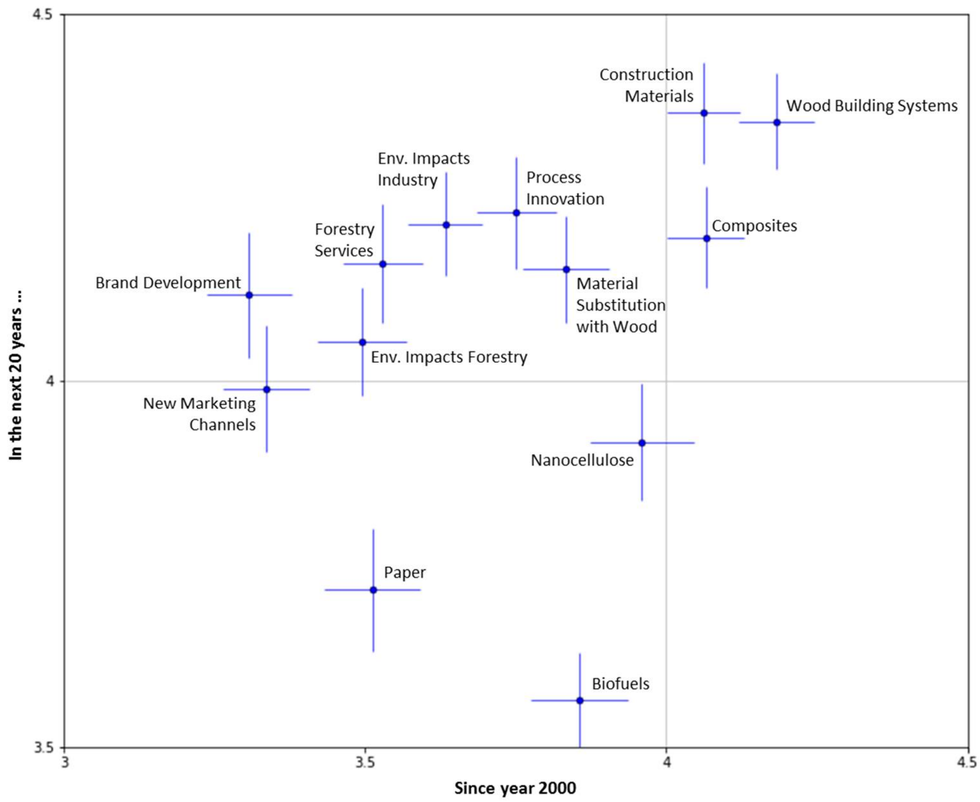

Figure 5. Performance Importance Grid (Scale from 1 = Strongly disagree, to 5 = Strongly agree).

Following the logic of performance-importance analysis, the innovations in the top left quadrant are those which should receive additional attention in the future since their performance is relatively low in relation to their future importance. Brand development, forestry services, environmental impacts of the industry, and process innovations would therefore qualify for the focus of increasing activities when considering the perceptions of these respondents. In addition, developing marketing channels, addressing better environmental impacts of forestry, and material substitution with wood all form a virtual second line of future potential focus in the industry innovation agenda.

4.2. The Influence of Forest Sector Involvement and Respondent Background

One strong influencer of personal involvement in forest-sector related topics is respondents' engagement with the forest sector through formal education, profession, or forest ownership [29,47]. People not involved in the sector have significantly lower levels of recognizing the innovations and often have high rates of 'I don't know' answers. People not involved in the sector mainly recognized innovations in traditional use such as building systems, wood construction materials, biofuels, and material substitution. However, when asked about the importance of future innovations, these differences decreased. Independent of involvement, the majority of respondents considered the innovations as important in the future. However, people involved in the sector put slightly more importance on the innovations than people not involved in the sector. This is particularly true in the case of the top performers (construction, building systems, and composites), which were all ranked more important and slightly more satisfying by involved respondents.

Nanocellulose was considered more important and biofuels less important by involved respondents. In a similar manner, paper-related innovations were considered as more important and satisfying among not involved respondents. However, the most notable differences between involved and not involved respondents were observed in the case of innovations in the top left quadrant. While brand development, forestry services, and process innovations were top rated items in terms of future importance by involved respondents, the not involved ones preferred environmental impacts of forestry and industry to require additional future consideration.

It can be noted that we also experimented with using exploratory factor analysis to analyze respondents' perceptions on 13 different innovations, and this was able to produce a two-dimensional solution that could be labeled as (1) Product Innovation and (2) Intangible Innovation. However, since only marginal differences emerged across respondent background on which one of these they perceived to be of higher importance, and no connection to Figure 1 type of innovation breakdown could be detected, these results were left out.

In applying the concept of hype cycle curves to the observations made in our study (Figure 6), the positioning of the different innovations remains generally vague with a few potential patterns. Hence, the purpose of this illustration (Figure 6) is to highlight differences between innovation expectations for these products arising from the data, but their placement on the curve is naturally not meant to be exact. Biofuels, for example, seem to have passed the peak of inflated expectations, reaching the trough of disillusionment. Building systems, construction materials, and composites may be considered on the slope to enlightenment towards the plateau of productivity. This may also apply to paper-based innovations, although on a much lower level. It seems that this category was likely assessed from the conventional pulp, paper, and paperboard products point of view. In contrast, the whole concept of nanocellulose was probably too far away from market application to allow for a proper consideration by the respondents without earlier exposure to forest sector innovation agendas. Hence, in the hype cycle model, nanocellulose may be placed at the very front end, and actually be placed even before the technology trigger.

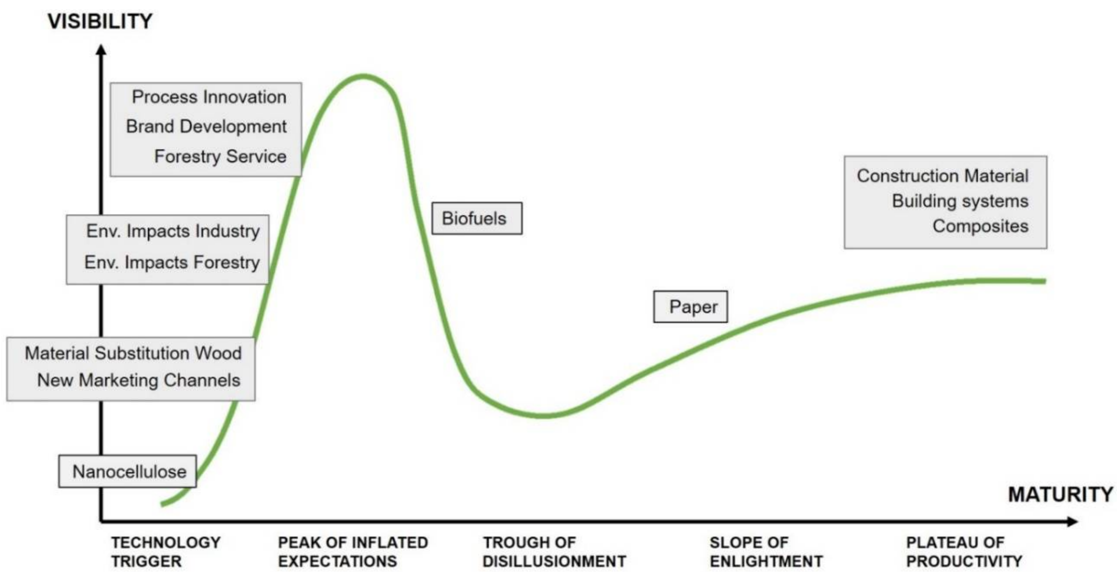

Figure 6. Schematic position of the investigated innovation areas in Gartner's technology hype cycle.

When interpreting the results in light of the hype cycle modelling approach, all other innovations considered in this study may be placed on the slope towards the peak of inflated expectations, as indicted by the importance ratings outperforming the satisfaction values. However, the position of these items remains a matter of personality. While respondents with sector involvement can be in favour of process innovations, brand development, and forest services, the ones not involved may prefer innovations reducing environmental impacts. This seems understandable considering the commercial relevance of the first group over the societal relevance of the second group. Although it would be an obvious assumption, the results do not suggest that the involved persons recognize innovations earlier and rate them generally as more important in comparison to persons who are not involved. However, the involved persons can have higher expectations regarding the products and consequently become more disappointed than the uninvolved ones.

5. Discussion

With reference to our two research questions, we conclude that the image of past forest sector innovativeness among the respondents from the four European forest rich countries is not necessarily a product-related issue. Instead, it is more based upon the respondents' awareness of the innovations, since, for instance, very few respondents had any view of the category that is seen as the most promising among industry itself, i.e., nanocellulose [34]. It was also perceived that in the next 15 years, the forest sector should continue to focus on wood construction and building system-related innovation efforts, likely linked to international policy targets related to climate change mitigation and carbon capture. This is also in line with previous research from Finland and Sweden, which states that wooden multi-story construction is considered to have the most promising new business opportunity for the future bioeconomy [23].

In parallel, the incapability of respondents to evaluate innovations like nanocellulose indicates a lack of awareness at least partly due to the fact that applications of nanocellulose products visible for consumers such as food packages are not yet in the markets [49]. There is an associated risk with the acceptability of products in Europe, for example, when comparing attitudes towards genetically modified food [50] or new and emerging sustainable energy technologies [51,52]. Therefore, in the use of nanocellulose, there also remain unknown territories, since potential risks have been identified in using the nanomaterials for different purposes [53].

Nevertheless, some basic limitations of the study need to be considered. Obviously, the convenience sampling of the survey and small sample size limit the generalization of results to larger populations. As can be seen from the socio-demographic description of the sample, it is clearly biased compared to the population of any of the countries in terms of education, age, amount of young respondents, and a higher than average likelihood of forest-based sector involvement. Hence, the results are not transferable to the entire population, but based on our findings and the developed questionnaire, a greater large-scale study can be recommended.

6. Conclusions

In conclusion, observed variation in perceptions of forest sector innovativeness calls for strengthening of both firm-level R&D activity and more national or regional level functioning of the forest bioeconomy innovation system. In addition, there is impetus for improving the forest industry image and acceptability among the general public by more effectively stewarding sustainability of resources, products, and manufacturing processes. Building higher general awareness on the emerging new products, such as nanocellulose, abreast with producing information, and communicating on the issues affecting their acceptability, is a prime example here. Furthermore, the perceptions of forest sector innovativeness may not only measure the "image" of the sector, but also how much the respondents in their role as end-users have been engaged in co-creative innovation activities. The observed variation in perceptions among the respondents on forest sector innovativeness calls for strengthening industry R&D, as well as improving societal awareness on ongoing innovation projects by better communication. Regarding future research needs, there is clearly room for improving the methodology, especially in addressing the drawbacks of the non-random sampling method used. Reaching a representative European sample on the general public would be very interesting to validate our preliminary insights. Additionally, acknowledging possible cross-country effects resulting from differences in terms of respondents' socio-economic background or prior awareness with industry or firm-level innovation agendas in respective countries merits further work.

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References

1. Hetemäki, L.; Hoen, H.; Schwarzbauer, P. Conclusions and policy implications. In *What Science Can Tell Us*; European Forest Institute: Joensuu, Finland, 2014; Volume 6, pp. 95–108.
2. European Commission. *Innovating for Sustainable Growth: A Bioeconomy for Europe*; European Commission: Brussels, Belgium, 2012.
3. European Commission. *A Blueprint for the EU Forest-Based Industries. SWD (2013)*; European Commission: Brussels, Belgium, 2013; Volume 345, p. 41.
4. Winkel, G. *Towards a Sustainable European Forest-Based Bioeconomy—Assessment and Way Forward*; European Forest Institute: Joensuu, Finland, 2017.
5. Pätäri, S.; Tuppura, A.; Toppinen, A.; Korhonen, J. Global sustainability megaforces in shaping the future of the european pulp and paper industry towards a bioeconomy. *For. Policy Econ.* **2016**, *66*, 38–46. [CrossRef]
6. Kleinschmit, D.; Lindstad, B.H.; Thorsen, B.J.; Toppinen, A.; Roos, A.; Baardsen, S. Shades of green: A social scientific view on bioeconomy in the forest sector. *Scand. J. For. Res.* **2014**, *29*, 402–410. [CrossRef]
7. Pfau, S.; Hagens, J.; Dankbaar, B.; Smits, A. Visions of sustainability in bioeconomy research. *Sustainability* **2014**, *6*, 1222–1249. [CrossRef]
8. Bugge, M.; Hansen, T.; Klitkou, A. What is the bioeconomy? A review of the literature. *Sustainability* **2016**, *8*, 691. [CrossRef]
9. Boons, F.; Montalvo, C.; Quist, J.; Wagner, M. Sustainable innovation, business models and economic performance: An overview. *J. Clean. Prod.* **2013**, *45*, 1–8. [CrossRef]
10. De Besi, M.; McCormick, K. Towards a bioeconomy in europe: National, regional and industrial strategies. *Sustainability* **2015**, *7*, 10461–10478. [CrossRef]
11. Müller, K.; Knierim, A. Bioökonomie und der mensch. *Biol. Unserer Zeit* **2012**, *42*, 123–128. [CrossRef]
12. Burns, C.; Higson, A.; Hodgson, E. Five recommendations to kick-start bioeconomy innovation in the UK. *Biofuels Bioprod. Biorefin.* **2016**, *10*, 12–16. [CrossRef]
13. Efroymson, R.A.; Kline, K.L.; Angelsen, A.; Verburg, P.H.; Dale, V.H.; Langeveld, J.W.A.; McBride, A. A causal analysis framework for land-use change and the potential role of bioenergy policy. *Land Use Policy* **2016**, *59*, 516–527. [CrossRef]
14. Tomei, J.; Helliwell, R. Food versus fuel? Going beyond biofuels. *Land Use Policy* **2016**, *56*, 320–326. [CrossRef]
15. Bicalho, T.; Bessou, C.; Pacca, S.A. Land use change within eu sustainability criteria for biofuels: The case of oil palm expansion in the Brazilian Amazon. *Renew. Energy* **2016**, *89*, 588–597. [CrossRef]
16. Hafner, A.; Schäfer, S. Environmental aspects of material efficiency versus carbon storage in timber buildings. *Eur. J. Wood Wood Prod.* **2017**, *4*, 32–41. [CrossRef]
17. Sikkema, R.; Dallemand, J.F.; Matos, C.T.; van der Velde, M.; San-Miguel-Ayanz, J. How can the ambitious goals for the eu's future bioeconomy be supported by sustainable and efficient wood sourcing practices? *Scand. J. For. Res.* **2017**, *32*, 551–558. [CrossRef]
18. European Union. *Directive 2008/98/ec on Waste (Waste Framework Directive)*; European Union: Brussels, Belgium, 2008.
19. Dahlbo, H.; Bachér, J.; Lähtinen, K.; Jouttijärvi, T.; Suoheimo, P.; Mattila, T.; Sironen, S.; Myllymaa, T.; Saramäki, K. Construction and demolition waste management—A holistic evaluation of environmental performance. *J. Clean. Prod.* **2015**, *107*, 333–341. [CrossRef]
20. Näyhä, A.; Hetemäki, L.; Stern, T. New products outlook. In *What Science Can Tell Us 6*; Hetemäki, L., Ed.; European Forest Institute: Joensuu, Finland, 2014; pp. 43–54.

21. Hellsmark, H.; Söderholm, P. Innovation policies for advanced biorefinery development: Key considerations and lessons from Sweden. *Biofuels Bioprod. Biorefin.* **2017**, *11*, 28–40. [CrossRef]
22. Hurmekoski, E.; Jonsson, R.; Nord, T. Context, drivers, and future potential for wood-frame multi-story construction in Europe. *Technol. Forecast. Soc. Chang.* **2015**, *99*, 181–196. [CrossRef]
23. Toppinen, A.; Röhr, A.; Pätäri, S.; Lähtinen, K.; Toivonen, R. The future of wooden multistory construction in the forest bioeconomy—A delphi study from Finland and Sweden. *J. For. Econ.* **2017**. [CrossRef]
24. Pelli, P. Services and industrial development: Analysis of industrial policy, trends and issues for the forest-based sector. *J. For. Econ.* **2017**. [CrossRef]
25. Ruef, A.; Markard, J. What happens after a hype? How changing expectations affected innovation activities in the case of stationary fuel cells. *Technol. Anal. Strateg. Manag.* **2010**, *22*, 317–338. [CrossRef]
26. Fenn, J. *Understanding Gartner's Hype Cycles*; Gartner Inc.: Stamford, CT, USA, 2006.
27. Jun, S.-P. An empirical study of users' hype cycle based on search traffic: The case study on hybrid cars. *Scientometrics* **2012**, *91*, 81–99. [CrossRef]
28. Korhonen, J.; Hurmekoski, E.; Hansen, E.; Toppinen, A. Firm-level competitiveness in the forest industries: Review and research implications in the context of bioeconomy strategies. *Can. J. For. Res.* **2018**, *48*, 141–152. [CrossRef]
29. Ranacher, L.; Lähtinen, K.; Järvinen, E.; Toppinen, A. Perceptions of the general public on forest sector responsibility: A survey related to ecosystem services and forest sector business impacts in four European countries. *For. Policy Econ.* **2017**, *78*, 180–189. [CrossRef]
30. Vargo, S.L.; Lusch, R.F. Service-dominant logic: Continuing the evolution. *J. Acad. Market. Sci.* **2008**, *36*, 1–10. [CrossRef]
31. Schumpeter, J. *The Theory of Economic Development*; Harvard University Press: Cambridge, MA, USA, 1934.
32. Hovgaard, A.; Hansen, E. Innovativeness in the forest products industry. *For. Prod. J.* **2004**, *54*, 26–33.
33. Eichhorn, S.J.; Dufresne, A.; Aranguren, M.; Marcovich, N.E.; Capadona, J.R.; Rowan, S.J.; Weder, C.; Thielemans, W.; Roman, M.; Renneckar, S.; et al. Review: Current international research into cellulose nanofibres and nanocomposites. *J. Mater. Sci.* **2009**, *45*, 1–33. [CrossRef]
34. Kangas, H. *Guide to Cellulose Nanomaterials*; VTT Reports 199; VTT: Espoo, Finiand, 2014; p. 97. (In Finnish)
35. Pätäri, S.; Kyläheiko, K.; Sandström, J. Opening up new strategic options in the pulp and paper industry: Case biorefineries. *For. Policy Econ.* **2011**, *13*, 456–464. [CrossRef]
36. Makovetskaya, O.; Bernadsky, V. Scientometric indicators for identification of technology system life cycle phase. *Scientometrics* **1994**, *30*, 105–116. [CrossRef]
37. Daim, T.; Suntharasaj, P. Technology diffusion: Forecasting with bibliometric analysis and bass model. *Foresight* **2009**, *11*, 45–55. [CrossRef]
38. Fenn, J.; Raskino, M. (Eds.) Hype cycle winners and losers. In *Mastering the Hype Cycle: How to Choose the Right Innovation at the Right Time*; Harvard Business School Press: Cambridge, MA, USA, 2008; pp. 3–24.
39. Jarvenpaa, H.; Makinen, S.J. Empirically Detecting the Hype Cycle with the Life Cycle Indicators: An Exploratory Analysis of Three Technologies. In Proceedings of the 2008 IEEE International Conference on Industrial Engineering and Engineering Management, Singapore, 8–11 December 2008; pp. 12–16.
40. Khodayari, M.; Aslani, A. Analysis of the energy storage technology using hype cycle approach. *Sustain. Energy Technol. Assess.* **2018**, *25*, 60–74. [CrossRef]
41. Weinfurter, S.; Hasen, E.N. Softwood lumber quality requirements: Examining the supplier/buyer perception gap. *Wood Fiber Sci.* **1999**, *31*, 83–94.
42. Martilla, J.A.; James, J.C. Importance-performance analysis. *J. Market.* **1977**, *41*, 77–79. [CrossRef]
43. Detlor, B.; Ball, K. Getting more value from the libqual+® survey: The merits of qualitative analysis and importance-satisfaction matrices in assessing library patron comments. *Coll. Res. Libr.* **2015**, *76*, 796–810. [CrossRef]
44. Sezhian, M.V.; Muralidharan, C.; Nambirajan, C.; Deshmukh, S.G. Developing a performance importance matrix for a public sector bus transport company: A case study. *Theor. Empir. Res. Urban Manag.* **2011**, *6*, 5–14.
45. Duke, C.R.; Mount, A.S. Rediscovering performance-importance analysis of products. *J. Prod. Brand Manag.* **1996**, *5*, 43–54. [CrossRef]

46. Ranacher, L.; Stern, T.; Wippel, B.; Dieguez, L.; Toppinen, A.; Lähtinen, K.; Kutnar, A.; Burnard, M.; Kitek Kuzman, M. What We Wood Believe? Societal Perceptions of the Forest-Based Sector (W3B–Wood Believe) Public Report on Major Project Results. 2017. Available online: https://www.researchgate.net/profile/Lea_Ranacher/publication/320225457_What_We_Wood_Believe_Societal_Perceptions_of_the_Forest-based_Sector_W3B_-_Wood_Believe_Public_report_on_major_project_results/links/59d5eeecaca2725954c78d43/What-We-Wood-Believe-Societal-Perceptions-of-the-Forest-based-Sector-W3B-Wood-Believe-Public-report-on-major-project-results.pdf (accessed on 2 May 2018).
47. Ranacher, L.; Stern, T.; Schwarzbauer, P. Do wood products protect the climate? Public perception of the forestbased sector's contribution to climate change mitigation. *Austrian J. For. Sci.* **2017**, *2017*, 281–298.
48. Ranacher, L.; Stern, T. Are your messages being heard? Evaluation of the forest-based sector's communication on sustainable forest management in Austria. *J. Austrian Soc. Agric. Econ.* **2015**, *25*, 159–168.
49. Bharimalla, A.K.; Deshmukh, S.P.; Vigneshwaran, N.; Patil, P.G.; Prasad, V. Nanocellulose-polymer composites for applications in food packaging: Current status, future prospects and challenges. *Polym. Plast. Technol. Eng.* **2017**, *56*, 805–823. [CrossRef]
50. Araki, M.; Ishii, T. Towards social acceptance of plant breeding by genome editing. *Trends Plant Sci.* **2015**, *20*, 145–149. [CrossRef] [PubMed]
51. Wüstenhagen, R.; Wolsink, M.; Bürer, M.J. Social acceptance of renewable energy innovation: An introduction to the concept. *Energy Policy* **2007**, *35*, 2683–2691. [CrossRef]
52. Assefa, G.; Frostell, B. Social sustainability and social acceptance in technology assessment: A case study of energy technologies. *Technol. Soc.* **2007**, *29*, 63–78. [CrossRef]
53. Camarero-Espinosa, S.; Endes, C.; Mueller, S.; Petri-Fink, A.; Rothen-Rutishauser, B.; Weder, C.; Clift, M.; Foster, E. Elucidating the potential biological impact of cellulose nanocrystals. *Fibers* **2016**, *4*, 21. [CrossRef]