Dissertationes Forestales 344

Service trends and the forest-based sector – an analysis of wood construction, the bioeconomy and evolving product service systems

Päivi Pelli

School of Forest Sciences
Faculty of Science, Forestry and Technology
University of Eastern Finland

Academic dissertation
To be presented, with the permission of the Faculty of Science, Forestry and Technology of the University of Eastern Finland, for public criticism in the auditorium N100 of the University of Eastern Finland, Joensuu, on 1st of December 2023, at 12 o'clock noon.

Title of dissertation: Service trends and the forest-based sector – an analysis of wood construction, the bioeconomy and evolving product service systems
Author: Päivi Pelli

Dissertationes Forestales 344
https://doi.org/10.14214/df.344

Thesis Supervisors:
Professor Jouni Pykäläinen
School of Forest Sciences, University of Eastern Finland, Finland

Professor of Practice Lauri Hetemäki, Ph.D. (Economics)
Department of Forest Sciences, University of Helsinki, Finland

Pre-examiners:
Professor Anders Roos
Department of Forest Economics, Swedish University of Agricultural Sciences, Uppsala, Sweden

Professor Rodrigo Rabetino Sabugo
School of Management, University of Vaasa, Vaasa, Finland

Opponent:
Professor Anne Toppinen
Department of Forest Sciences, University of Helsinki, Finland

ISSN 1795-7389 (online)
ISBN 978-951-651-778-3 (pdf)

Publishers:
Finnish Society of Forest Science
Faculty of Agriculture and Forestry of the University of Helsinki
School of Forest Sciences of the University of Eastern Finland

Editorial Office:
Finnish Society of Forest Science
Viikinkaari 6, 00790 Helsinki, Finland
https://www.dissertationesforestales.fi

Pelli P. (2023). Service trends and the forest-based sector – an analysis of wood construction, the bioeconomy and evolving product service systems. Dissertationes Forestales 344. 50 p. https://doi.org/10.14214/df.344

ABSTRACT

This thesis examines service trends in the operating environment of the forest-based sector on the level of companies and the evolving industrial production systems. The analytical framework is based on sociotechnical transitions research and service research knowledge bases on services and ongoing organizational changes in production and the markets. Three empirical studies have been conducted to detect service trends by investigating: 1) role of services in the European RDI roadmaps of the forest-based sector and parallel industries, 2) distribution of value and business model changes in the supply networks of industrial wood construction, and 3) market offerings and service innovation in sustainable housing construction projects in Finland. The empirical studies demonstrate evolving product service systems (PSS) in the further downstream customers of the forest-based sector, exemplified here by the construction sector. A game changing question for the forest-based sector is whether its industries and organizations focus on serving the PSS of today or whether they will seek to contribute to the next generation of PSS solutions, exemplified here by the potential for system change in construction regime. None of today's PSS models alone capture the future PSS, but alternative scenarios are needed and assessment of their implications for the forest-based sector and future bioeconomy.

Key words: forest bioeconomy, operating environment, sociotechnical transitions, services, business changes, multi-level perspective (MLP)

Pelli P. (2023). Service trends and the forest-based sector – an analysis of wood construction, the bioeconomy and evolving product service systems. Dissertationes Forestales 344. 50 p. https://doi.org/10.14214/df.344

TIIVISTELMÄ

Tämä tutkimus tarkastelee palvelukehitystä metsäalan yritysten toimintaympäristössä sekä yritysten liiketoiminnan muutoksina että laajemmin osana tuotantojärjestelmän evoluutiota. Tarkastelumalli perustuu yhteiskunnallisteknisen muutoksen teoriaperustaan, johon yhdistetään palvelututkimuksen alan käsitteitä kuvata palvelukehitykseen liittyviä organisatorisia muutoksia tuotannollisessa toiminnassa ja markkinoilla. Tutkimuksessa on tehty kolme erillistutkimusta. Palvelukehityksiä tunnistetaan tarkastelemalla 1) palveluita eurooppalaisissa TKI-tiekartoissa metsäalalla ja rinnakkaisilla aloilla, 2) arvon jakautumista ja liiketoimintamallien muutosta teollisen puurakentamisen toimitusverkostoissa sekä 3) markkinatarjoomia ja palveluinnovaatiota kehittyvissä tuotepalvelujärjestelmissä kestävän asumisen rakennusprojekteissa Suomessa. Näin havainnollistetaan tuotepalvelujärjestelmien kehittymistä metsäalan yritysten asiakasaloilla, joista tässä esimerkkinä on käsitelty rakennusalaa. Tutkimus nostaa metsäalan pelinmuuttajakysymykseksi, keskittyvätkö sen yritykset ja organisaatiot palvelemaan nykyisiä tuotepalvelujärjestelmiä vai tavoittelevatko ne kehittää seuraavan sukupolven tuotepalvelujärjestelmiin liittyviä ratkaisuja osana vallitsevan tuotantotavan, tässä rakentamisen regiimin, muutosta. Mikään nykyisistä tuotepalvelujärjestelmämalleista ei yksinään kuvaa tulevia tuotepalvelujärjestelmiä. Palvelukehityksestä tarvittaisiinkin vaihtoehtoisia skenaarioita ja arviota siitä, mitä eri kehityskuluista seuraa metsäalalle ja tulevaisuuden biotaloudelle.

Asiasanat: metsäbiotalous, toimintaympäristö, yhteiskunnallistekninen siirtymä, palvelut, liiketoimintamuutos, monitasomalli (MLP)

ACKNOWLEDGEMENTS

In 2001 Richard Normann entitled his book “Reframing Business: When the Map Changes the Landscape”. The map that he offered to the business strategists unfolded the economy as a web of activities and actors co-producing value. ”Today’s products and services are more about knowledge and linkages than about steel and mass”—or, rephrasing it a bit—than about wood and biomass. This metaphor of maps and a landscape followed my research journey on services in the forest sciences, the engineering and business sciences, and finally, the evolving system change theorizing. The idea remains intriguing even today: What could the emerging bioeconomic era bring to the fore as service configurations beyond those already captured in the market models? Finally, my investigation was about service economy already woven into the forest-based sector, and how we could better understand the maps of today.

This journey was made with the support of the Doctoral Programme in Forest Sciences (at present: Doctoral Programme in Science, Forestry and Technology), for which I express my sincere gratitude for the Faculty of Science and Forestry (at present: Faculty of Science, Forestry and Technology). Warm thanks to the supervisors Prof. Jouni Pykäläinen and Dr. Lauri Hetemäki for their patience with my unbundling and re-bundling of service conceptualizations. Moreover, I wish to acknowledge the support of my co-authors—those co-authoring the three articles included in this dissertation as well as those collaborating on other pieces of work. Prof. Teppo Hujala and the futures-oriented projects he initiated gave me the necessary push toward the finishing line, including the support of the Saastamoinen Foundation during the final step. I am thankful to the pre-examiners Prof. Rodrigo Rabetino and Prof. Anders Roos for their insightful feedback and valuable reflections for future research, too. I would also like to thank Gary Attwood for proofreading the thesis summary.

While the Doctoral Programme support was elementary for the study, travel grants enabled me to carry out interviews, but equally important, they allowed interaction with the cross-disciplinary communities of forest sciences, the Naples Forum on Service, the RESER conferences on service research, as well as the Finnish futures research community. The discussions, constructive critiques and open curiosity in these research communities encouraged me to continue the work. For this, I am grateful to the Foundation for Economic Education (Liikesivistysrahasto), the Finnish Society of Forest Science’s IUFRO grant, and the Metsämiesten Säätiö Foundation.

Naming individually all those who contributed to this journey is impossible. I am truly grateful to the company representatives, in particular, the companies who opened their operations for detailed scrutiny, as well as the representatives of the forest sector and construction sector, administration, and academy who contributed with the necessary information and reflections throughout the work in progress. Without your keen interest in learning more about the operating environment and readiness to challenge the accustomed ways of seeing the landscape, this research would not have been possible.

Last but not least, warm thanks to my family and friends—not to forget Topi and Masa, my sunshine and storms in four legs and full of service attitude—you all laid the foundations of the landscape visible to me and the horizons worth exploring further.

Polvijärvi, 15.10.2023

Päivi Pelli

LIST OF ORIGINAL ARTICLES

This thesis concludes the analyses published in three research articles, referred in the text by their Roman numerals. Articles are reprinted with the kind permission of the publishers: article I in the Scandinavian Journal of Forest Research, © copyright # 2017, reprinted by permission of Informa UK Limited, trading as Taylor & Taylor & Francis Group, http://www.tandfonline.com, and articles II and III by permission of Elsevier http://www.elsevier.com.

I Pelli P, Haapala A, Pykäläinen J (2017) Services in the forest-based bioeconomy – analysis of European strategies. Scand J For Res 7: 559-567. https://doi.org/10.1080/02827581.2017.1288826

II Pelli P, Lähtinen K (2020) Servitization and bioeconomy transitions: Insights of prefabricated wooden elements supply networks. J Clean Prod 244, article id 118711. https://doi.org/10.1016/j.jclepro.2019.118711

III Pelli P (2021) Service innovation and sustainable construction: analyses of wood vis-à-vis other construction projects. Cleaner Engineering and Technology 2, article id 100061. https://doi.org/10.1016/j.clet.2021.100061

Author's contributions in the co-authored articles

	I	II	III
Conception and design	PP, AH, JP	PP, KL	PP
Data collection	PP	PP	PP
Data analysis	PP	PP	PP
Writing the article	PP, AH, JP	PP, KL	PP
Overall responsibility	PP	PP	PP

PP = Päivi Pelli, AH = Antti Haapala, JP = Jouni Pykäläinen, KL = Katja Lähtinen

TABLE OF CONTENTS

ABSTRACT 3
TIIVISTELMÄ 4
ACKNOWLEDGEMENTS 5
LIST OF ORIGINAL ARTICLES 6
LIST OF ABBREVIATIONS 8
INTRODUCTION 9
Background and motivation for the research 9
Services as a multifaceted trend for the forest-based sector 9
Services and organizational changes in the forest-based sector 11
Ambiguity of services in the future forest bioeconomy 13
Research questions 14
Research approach and expected contribution 14
ANALYTICAL FRAMEWORK 17
Multi-level perspective (MLP) and the evolving sociotechnical landscape 17
Dynamic balance of rulesets in the sociotechnical regimes 20
Service trends at multiple scales of organizational change 22
METHODOLOGY 24
Research design 24
Data and methods 26
RESULTS 30
Service trends: services, organizational changes and the potential for system change 30
Services in the RDI roadmaps of industrial systems 31
Servitization and increasingly integrating industrial production systems of construction 31
Evolving product-service systems in the markets of sustainable construction 32
Implications for the forest-based sector and evolving bioeconomy 33
DISCUSSION AND CONCLUSIONS 36
Questions on service trends for the forest-based sector 36
Contribution and implications 38
Limitations 39
Future research 40
REFERENCES 42

LIST OF ABBREVIATIONS

b2b business-to-business
EU European Union
FTP forest-based sector technology platform
ISIC International Standard Industrial Classification
ICT information and communication technology
IT information technology
KIBS knowledge-intensive business services
MLP multi-level perspective (on sociotechnical change)
NACE Statistical classification of economic activities in the European Community
OECD Organisation for Economic Co-operation and Development
PSS product-service systems
RDI research, development and innovation
RQ research question
SDL service-dominant logic

INTRODUCTION

This section explains the motivation for research into service trends, the research questions, and expected contribution of this thesis.

Background and motivation for the research

Services are recognized as important for the forest-based sector, and its renewal. The research on service trends in the forest-based sector has three overlapping research angles, which often remain detached: the macroeconomic developments of the operating environment, the organizational changes ongoing in the forest-based sector, and new models of a future bioeconomy.

Services as a multifaceted trend for the forest-based sector

The increasing role of services for employment and income in the developed economies, i.e., tertiarization of the economy, as well as the observation that many industries add services to their products, i.e., servitization in manufacturing, have drawn the forest-based sector research's attention to service developments. Services have been assessed with respect to new business opportunities particularly in rural areas (Niskanen et al. 2007; Niskanen et al. 2008; Weiss et al. 2011), structural changes and more versatile opportunities in the traditional forest industry countries such as Finland (Hetemäki 2011; Hetemäki and Hänninen 2013), and in terms of the renewal of the forest industry (Toppinen et al. 2013). While the forest-based sector strategies and industrial development in this sector focus on tangible products and wood as raw material for several uses, the intangible services remain an ambiguous target for research (Näyhä et al. 2015).

The vagueness inherent to services as 'something intangible' tends to underrate services in economic assessments as peripheral or even residual of the primary production and manufacturing industries (Gallouj and Windrum 2009). Nevertheless, not only did services become the largest economic sector in most Western economies already in the 1970s, also the economic activities of the primary, secondary, and tertiary sectors are now understood to be closely interconnected (Wölfl 2005). Today service sectors represent 70-80% of the national value added and employment in developed economies. Services, such as RDI, engineering, system management and logistics, are interwoven in the manufacturing processes, and technical expertise, installation, and maintenance support for the customers are necessary services for the adoption of the manufactured products (De Backer et al. 2015).

Progress in information and communication technology and the removal of trade barriers have speeded up the international distribution of production tasks, and the fragmentation of value chains. Business services together with logistics, IT and infrastructure services have contributed to the emergence of global value chains, and the continuous search for competitiveness and efficiency across the international markets (De Backer et al. 2015). The ever-changing combinations of products and services illustrate the servicification of global value chains (Miroudot and Cadestin 2017). Servicification is understood as a broader question than the mere efficiency of manufacturing operations: not only manufacturing tasks are distributed internationally, but also international trade of services has increased (Sáez et al. 2014). Gaining an accurate picture of material and immaterial resource flows is

increasingly difficult. What used to be an appropriate way to assess manufacturing processes as value adding chains, does not fully capture value creation in service networks, which facilitate operations across several industries, and solve user problems in interaction between multiple firms across the globe (Miroudot and Cadestin 2017).

In the 21st century, the question no longer concerns manufacturing versus services, but rather, it concerns the intersectoral relationships, technological advancements leading to creation of new services, and the qualitative changes characteristic to these developments (Maroto and Rubalcaba 2008). As illustrated by the global value chains, services are necessary infrastructures both for the manufacturing and service industries, and for trade. Standards, such as the nomenclatures for international trade and economic activities, have been changed in order to provide more information on services, notably the World Trade Organization's General Agreement on Trade in Services in 1995, and the revisions of the ISIC and NACE classifications (Eurostat 2008; Miles et al. 2018). The role of services, particularly business services and service innovation, is important in support of well-functioning innovation systems and economic growth, as noted, for example, in the OECD report on knowledge-intensive service activities in 2006, and the EU High Level Group on Business Services in 2014.

Drivers, such as the digital transformation, or the Algorithmic Revolution, as it is called by Zysman (2006) influence the economy, irrespective of whether it concerns tangible or intangible resources, or material or immaterial processes. The blurring of manufacturing and services, together with digital manufacturing, robotics, bio- and nanotechnology, photonics and other enabling technologies could revolutionize manufacturing business models (De Backer et al. 2015). Examples of visionary technology futures have been portrayed, for example, in the "next production revolution" (OECD 2017), and "green and digital future" (Muench et al. 2022).

Considering these evolving themes, it is not surprising that the forest-based sector research has been interested in services, and the impact of related changes in the operating environment. Researchers have formulated several questions for further analysis. For example, Hetemäki (2011) asks whether the traditional forest industry countries like Finland shift toward services, and whether know-how could become the engine of forest-based businesses if most of the manufacturing activities were located elsewhere. Similarly Toppinen et al. (2013) discuss whether the renewal of the forest industries is in fact a move toward business-to-business services. Näyhä et al. (2015) emphasize that more research is needed on how such developments would affect the forest product value-added chains and, for example, the geographical location of production tasks, or new business opportunities and the skills needed to capture value. Murcia et al. (2018) in turn ask what the long-term effects of tertiarization trends will mean for forests in developed and developing regions.

Having stated the recognized need to understand service-related developments in the operating environment, these trends remain scarcely investigated in the forest-based sector research. Data and information are lacking to assess services and their economic prospects, such as the export potential of consultancy, education and training, or industry-related services (Hetemäki 2011). Nor are there timeseries data on forest-related services such as forest-based tourism, health and recreation services, and their outlook. Without data, econometric analyses and systematic assessments on service trends or their impact on structural changes in the forest-based sector are missing (Hurmekoski and Hetemäki 2013). Instead, the services trends are assessed regarding their impact on the demand for forest products and services. The attention, thus, is mainly on the market changes of the forest-based sector organizations as of today. This especially includes how service trends affect the

use of forests, and further, how forestry operations and knowhow are changing. Furthermore, it includes how the forest industries and their product portfolios are changing, and consequently, how the forest industry countries, such as Finland, are changing.

In the bioeconomy investigations services are estimated as part of the bioeconomic sector. Thus, the share of support services, biotechnology, and other servicing for production and conversion of renewable biological resources is approximated in a similar manner than it is done in other manufacturing and processing sectors (Rönnlund et al. 2014; Efken et al. 2016). Or the tertiary bio-based production is defined separately as the further refining of manufactured products, logistics of the bio-based goods, and the intermediating services for final consumption of such products (Kuosmanen et al. 2021, European Commission 2022). These approaches illustrate the challenges in assessing services in bioeconomic systems. Even though the importance of services has been recognized explicitly, the current statistics are not apt to capture the service activities—not to mention the new services that are currently being developed.

Furthermore, not only is data missing on bioeconomy services, but also the bio-based products, their new markets, and circular production processes are difficult to quantify (Hetemäki 2014; Hurmekoski et al. 2018; Kunttu et al. 2020). Cross-sectoral developments challenge the traditional industry boundaries. The question is not only about services, but services are a necessary part of the economic system which is developing.

Services and organizational changes in the forest-based sector

The forest-based sector research on services, or trends in the markets focuses mainly on forest-based sector operations. Services and other intangibles, such as product and process qualities, renewable and traceable raw materials, environmental sustainability, and corporate social responsibility are recognized as part of the market offering of wood products (Toivonen et al. 2005; Wang et al. 2015; Holopainen 2016; Räty et al. 2016). Here services are a marketing question for the wood industries. Investigations on the renewal of wood industries have in turn assessed services as a question of competitiveness: services could be an element of the business performance of sawmills (Lähtinen and Toppinen 2008); a company's competitive position could be improved by moving downstream in the value-added chain, such as wood construction companies extending to real estate services (Brege et al. 2014), or the adoption of new digital tools could lead to business model change and service-based strategies in the wood industries (Makkonen 2018). There is potential in services that are supplementary to wood products, but services are challenging for the industry (Hansen 2016; Makkonen 2019; Näyhä 2020): innovations in new products and services are dealt with using a product-oriented approach, while customer-orientated business strategies, service skills, and service-based thinking are relatively new in the forest-based sector.

Additionally, studies on service activities, such as forestry services and forest owner services, have identified ongoing changes. The markets for forestry services have changed due to outsourcing and the increasing role of service industry suppliers in forestry (Clark 2005; Anderson 2006). Furthermore, changing forest ownership, and new customer needs are expected to create business opportunities in green services (Hull and Nelson 2011). In such markets, conservation and biodiversity knowledge can be a strategic capability for advisory forestry organizations (Wolf and Primmer 2006). Service provisioning for forest owners is expected to evolve to become more customer-orientated and value-based, but

again, the renewal of forestry organizations is foreseen to be slow (Mattila and Roos 2014; Mattila 2015; Andersson and Keskitalo 2019).

Studies in the forest-based sector have applied analytical tools from the service and business research disciplines. For example, decision support systems have been examined concerning their service processes and various elements such as typologies of forest owners as customers, and the role of experts in forest extension services (Hujala et al. 2007). A better understanding of the service process could help to develop the decision support systems further.

Researchers have followed the recent progress in the service research disciplines and have adopted new approaches to study forest-based sector questions. For example, the service-dominant logic (SDL) by Vargo and Lusch (2004), and the service logic by Grönroos (2006) in the marketing management field are used in forestry services related questions (Mattila 2015; Berghäll 2018; Hujala et al. 2019), as well as for the sustainable business models of circular bioeconomy (Lähtinen and Häyrinen 2022). Furthermore, interactions in wider service systems have been examined, for example, by applying the value innovation and social innovation conceptualizations for assessing the novel business models of forest leasing value networks (Laakkonen et al. 2018), or for the non-wood forest products and their market creation (Weiss et al. 2019).

The question, thus, is not only about services or service providers per se, but the organizational changes. The above-mentioned studies have drawn attention to questions: What are the sources of competitiveness for forest industry companies or forestry service providers? How will customers adopt new solutions? How can knowledge-based decision making or innovation and sustainability be supported in the forest-based sector?

However, the research field on services and service remains fragmented. For example, studies on forest industry companies and their machinery suppliers (Kuusisto 2006) or their customers (Davidsson et al. 2009; Viitamo 2013) may remain unrecognized in the forest-based sector if such studies conclude their observations on servitization in manufacturing or processing industries rather than the forest industries specifically. The engineering disciplines are of particular interest for the forest-based sector analysis, since they scrutinize services in product-oriented firms and overall, as part of industrial production. Several concepts have been developed to describe combinations of products and services, such as product-service systems (PSS), hybrid offerings, integrated solutions or complex product systems (summarily in Rabetino et al. 2018). These illustrate company-level investigations of the manufacturing processes which also are connected to the macroeconomic phenomena of servicification and international distribution of value chains. The concepts describe change in the company operations and the markets. Business models are changing from products to services, and more service-based thinking necessitates a new kind of strategic orientation as well as new capabilities.

Changes in the markets of forest products and services are more complex when considering the impact of technology development on services. Studies on digital forest information platforms (Pynnönen et al. 2021), virtual reality forest management services (Holopainen et al. 2020), and the data and material flows in the forest-based industries and their customers, such as the textile industry (Luoma et al. 2022), illustrate assessments of technology-enabled services and related changes in the forest-based sector. The changes related to services which are ongoing both within the forest-based sector and in the operating environment remain difficult to grasp.

Ambiguity of services in the future forest bioeconomy

The brief summary of the forest-based sector research above illustrates the service trends in a changing operating environment. The competitive positions of forest-based sector organizations and companies are changing, and new opportunities as well as new competitors are emerging. This reorganization of operations is ongoing because enabling technologies, new markets, and processes are still developing. The value adding networks, including new services and the services to support the adoption of new bio-based solutions are evolving together with new bioeconomic solutions (Pelli et al. 2018). Bioeconomy services are emerging as a response to the changing operating environment, technologies, and knowledge. Investigations of new knowledge-intensive business services are necessarily cross-sectoral in response to the changing operating environments and new technologies (Miles et al. 2018). Analogous with the development of ICT leading to emergence of totally new service activities, also biotechnology is likely to create new services and an industry on their own (Gokhberg et al. 2013).

Two research angles on service trends, examining macroeconomic and organizational changes, are often assessed separately in forest-based sector research. Consequently, broader themes such as the interconnection of service research and the algorithmic revolution may remain unrecognized in the forest-based sector. As examples, the value-based thinking described in service-dominant logic conceptualizations is already being applied to the management and engineering of automated systems (Spohrer and Maglio 2008; Breidbach et al. 2018), and service-based thinking is being incorporated in the technological scenarios of the future service economy (Chang et al. 2014). Both illustrate profound system changes, not a mere shift from products to services.

Compared with research on bioeconomic developments, studies investigating the implications of service trends are few. The forest bioeconomy is understood by stakeholders in several ways: the forest bioeconomy developments can be studied as the forest-based sector renewal, the new bio-based industries emerging as well as the potentially contradictory visions of a bioeconomic system (Hurmekoski et al. 2019; Korhonen et al. 2020). There is no similar assessment of service developments, where service trends were recognized both as service sector developments, emerging new service industries as well as a systemic change to a service-based (bio)economy.

Instead of the socio-techno-economic questions related to service trends, the forest-based sector research draws attention to a different kind of service-based thinking concerning natural resource questions, namely, ecosystem services. These services that forests produce remain narrowly incorporated in economic thinking and the markets of evolving bioeconomy (Hetemäki et al. 2017; European Commission 2022). They include provisioning services such as the production of food, water, wood, and other raw materials; regulating services such as carbon storage and climate regulation; supporting services such as nutrient cycles and oxygen production; cultural services such as providing spiritual and recreational benefits and aesthetic experiences. Integration of these services in bioeconomic models is sought for. As solutions are proposed natural capital accounting (Hetemäki et al. 2017), including value-in-impact of ecosystem services in the forest products market analysis (Matthies et al. 2016), as well as assessing the benefits of forests to human health as tertiary products (Herpin-Saunier et al. 2018).

Such questions are challenging to describe with the extant market structures, for example as developments of the forest-based sector and services. Rather, the ideas are similar to those elaborated in futures research as profound systemic changes to “the society of intangible

needs" by Malaska (1999) or "the upcoming seventh K-wave" by Wilenus (2021). Recently a more profound change of the economic system has gained attention, such as the biodiversity economics elaborated in the Dasgupta report (2021). As Hetemäki (2014, p. 15) states on the present era of changes: "The old models, methods and data are not necessarily very helpful in describing structural changes and the future—not only do they need to be updated, new models and methods must be introduced."

To conclude, forest-based sector research has recognized the services phenomena to be important in analyzing the forest-based sector, its structural changes, the evolving bioeconomy, as well as the challenges related to natural resources and their sustainable use. The overall picture, however, is scattered. Consequently, it remains an ambiguous target to capture and elaborate the service trends for the forest-based sector and future bioeconomy. Better analytical tools are needed.

Research questions

This research sets out to improve understanding of service trends in the forest-based sector and its operating environment. Empirical data is lacking for the forest-based sector services and there is a need for conceptual clarity about service trends. The overarching question directing this research, thus, has been the multifaceted nature of service trends, and the ambiguity of defining targeted questions for analyzing this phenomenon or its outlook for the forest-based sector.

Firstly, the forest-based sector research already elaborates several levels of analysis concerning the changing operating environment. Service trends are a macroeconomic phenomenon, which affects the markets of the forest-based products, and consequently, has an impact on the operations of the forest-based sector organizations as well as use of forests. Organizational changes, in turn, often focus on the forest-based industries and forestry services without analyzing the broader context. Secondly, the structural changes already discussed in the forest-based sector have several implicit directions. In addition to shifts from products to services, and the search for improved competitiveness through the diversification of product portfolios and development of new services in the forest industry companies, the question is that of new bioindustries or a bioeconomic sector emerging, and potentially, also moving toward bioeconomic thinking which goes beyond the services exchanged in the markets of today.

This research has a strong empirical stance, on one hand, to observe changes ongoing, and on other hand, assess them vis-à-vis the forest-based sector and bioeconomy. The research questions are:

RQ1: What service trends are detectible in the operating environment, and how do they connect with the forest-based sector changes?

RQ2: What implications do service trends have for the forest-based sector and bioeconomy?

Research approach and expected contribution

This research in the field of forest policy and economics is phenomenon driven. Its starting point is pragmatic: to gain a better understanding of service trends ongoing in the operating environment. The service trends have already been assessed in the forest-based sector

research as macroeconomic and organizational changes, but the overall picture of the developments or their impact on the forest-based sector is fragmented (Figure 1). Consequently, it is challenging to define models and methods necessary for describing structural changes or for assessing the future.

Trends are perceivable from the past as directions of change, which may be quantified or qualitatively described as development tendencies. To detect a trend, the accumulation of knowledge over a long period of time is necessary. Figure 1 illustrates different angles of forest-based sector research on service trends. Servicification research provides one way to analyze the macroeconomic trends and their impact on forest-based sector operations, such as the international distribution of tasks in global value chains. Studies on organizational changes, in turn, elaborate both the shift from products to services and more organizational culture related changes toward customer-orientated strategies or value-based thinking. Neither the forest-based sector structural changes nor the future bioeconomy can be captured without a better understanding of the developments in services.

Phenomenon-driven research investigates a perceived change, something that is unexpected or in question compared with the established system and its mechanisms. As defined in the organizational research for change management, it is "problem-oriented research that focuses on capturing, documenting, and conceptualizing organizational and managerial phenomena of interest in order to facilitate knowledge creation and advancement" (Schwartz and Stensaker, 2016, p. 245). Accordingly, this research seeks to contribute to the analysis of the forest-based sector changes by providing means to organize knowledge on service trends as well as sharpen the analytical focus of the forest-based sector investigations on this phenomenon. More targeted questions are crucial for collecting evidence on service trends, and further, for supporting policy and decision making toward the forest bioeconomy and sustainable use of natural resources.

The research is at its foundational premises cross-disciplinary, and it combines:

- sociotechnical transitions research as the theoretical basis for complex systems and their change, and in particular, the multi-level perspective (MLP) as an analytical tool to study system changes;
- services research and service research disciplines as a knowledge base for services and service trends, including research-based conceptualizations and evidence on ongoing organizational changes.

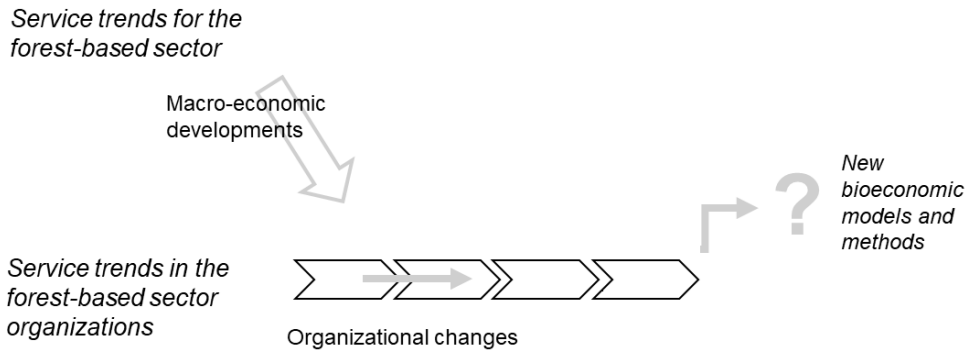

Figure 1. Pragmatic starting point of the research to gain better understanding on service trends in the operating environment vis-à-vis the forest-based sector and bioeconomy.

This thesis consists of three studies and a synthesis. Articles I-III contribute each a distinct empirical perspective on service trends in the context of the forest-based sector. The articles can be read separately in answer to RQ1-RQ2 in three different, but at the same time overlapping contexts: the forest-based sector and parallel industries; wood products industries and the supply networks for industrial wood construction, and wood construction and the evolving markets for sustainable housing solutions. This thesis explains the theoretical basis and the analytical framework of the research (section 2), describes the methodology used in the empirical studies (section 3), summarizes results from the empirical studies (section 4), and concludes key questions for the forest-based sector, and discusses the contribution and the limitations of this research (section 5).

ANALYTICAL FRAMEWORK

The analytical framework in this thesis builds on evolutionary theorizing in sociotechnical transitions research. A multi-level perspective (MLP) on sociotechnical system change is used as a device to detect service trends in the context of the forest-based sector and bioeconomy. MLP has been developed as a conceptual tool for process-narratives for long historical changes in complex sociotechnical systems (Geels 2002). This section explains how MLP is here applied to collect evidence on service trends and to examine the changes in the operating environment.

Multi-level perspective (MLP) and the evolving sociotechnical landscape

Research into sociotechnical transitions seeks to better understand systemic changes and system innovations, and how systems, such as energy or mobility systems, could be transformed (Grin et al. 2010). Transitions are non-linear and difficult to manage due to complex interdependent processes. For example, directing a system to adopt a radically new technological solution or move toward improved sustainability requires changes in the operations of multiple actors, in individual organizations, in production and consumption modes, necessary infrastructure as well as institutions. Such changes typically take several decades to realize. They are "more evolution than revolution" as described by Rotmans et al. (2001). Gradual incremental changes and radical disruptive change are both part of sociotechnical transitions. Structural change is here defined as a shift between system elements, while a transition is a move from one system state to another (Loorbach et al. 2017). In other words, a transition is more profound than the structural changes of an industry or part of the economy.

In the analysis of complex systems, the system boundaries are defined for the purpose of the analysis: system models are tools that can be used to investigate real-life phenomenon, but the system boundaries cannot be found as easily in the operating environment. Even though the models and conceptual tools do not provide means to predict the future developments, they assist in making sense of the operating environment, recognizing patterns of change from the past, elaborating these developments toward the future, as well as seeking for advancing the desired outcomes (Grin et al. 2010).

The multi-level perspective (MLP) on sociotechnical change defines its target system based on the societal function that the system performs (Geels 2002; 2005). Change in the systems, such as energy, mobility, housing, food and agricultural systems are described across three analytical levels (Rip and Kemp 1998; Geels 2002): the landscape of the exogenous, relatively fixed infrastructures, as well as slow-to-change trends and abrupt shocks; the regime of the established rules of the game; and niches, as spaces of experimentation for ideas such as radically new technologies. Different dynamics characterize the stable landscape and the dynamic balance of the established regime, and the competing niches. The landscape's exogenous developments create windows of opportunity for system change, place pressure on the regime and create momentum for the breakthrough of niche technologies. The outcome, in turn, depends on niche maturity and alignment between the three levels (Geels and Schot 2007). Thus, whether the regime persists the pressures, adjusts its processes, or a leap from one system state to another becomes possible.

On its theoretical basis, MLP is a multi-ontology construct and it accommodates concepts of evolutionary economics, innovation studies, science and technology studies, and institutional theories. It is a crossover between theories (Geels 2010; 2020).

Evolutionary economic theories describe economic change with patterns of innovations across populations of firms; in which breakthroughs of radical innovations disrupt the accumulated competences, and lead to system discontinuities—resulting in the creative destruction, as described by Schumpeter (1939). Mechanisms of variation, selection, and retention explain why incremental rather than radical change characterizes the established sociotechnical systems. Technological regimes evolve along technological trajectories because cognitive routines and search heuristics drive engineers to search for solutions from the same direction (Nelson and Winter 1982; Dosi 1982). Path dependencies are built within the system, including its investments, infrastructures, and knowledge (Tushman and Anderson 1986). Network externalities strengthen the chosen technology path; the more a technological innovation is used, the more it spreads in a wider variety of application fields (Arthur 1988). On a macroeconomic scale, the co-evolution of science, technology, economy, politics, and culture results in pattern of long waves, as explained in the techno-economic paradigms by Freeman and Loucã (2001).

While evolutionary economics focuses on lock-in mechanisms, transition studies seek to explain the lockouts, thus, the change from one system state to another (Elzen et al. 2004). Technology is not an exogenous factor of change, but rather, part of the social co-evolution. Variation, selection, and retention mechanisms of the sociotechnical system are described from a social scientific, quasi-evolutionary, perspective (Schot and Geels 2007; Geels 2010). Institutional theories provide detail on the interpretative socio-cultural processes of change, and the tensions inherent in interactions within the sociotechnical systems. The search heuristics, rules and routines not only constrain, but also enable action (DiMaggio and Powell 1983; Scott 1995). They are part of the ruleset and grammar of sociotechnical regimes governing how actors, such as companies and organizations, operate and orientate in their environment (Rip and Kemp 1998).

MLP has been used for historical process narratives of technological change, as well as for examining sustainability transitions (Geels 2011; Markard et al. 2012). Geels (2010; 2020) emphasizes the use of MLP for heuristics. In this research MLP is not used to explain changes over time, but to detect service trends in the operating environment, and to examine changes in the operating environment, as well as in the forest-based sector toward a bioeconomy.

MLP—or sociotechnical transitions models, overall—draw limited attention to services or service trends. Services are recognized as complementary assets for the established regimes, such as service networks or distribution channels (Geels 2011; 2018). They are intermediaries which are important for the diffusion of innovations. Knowledge-intensive business services (KIBS), research and technology organizations, and public and industry organizations also play a more systemic role in the network structure of the technological innovation system (van Lente et al. 2003; Kivimaa et al. 2019). They influence the processes of innovation systems. The evolving service-based economy, in turn, can be depicted as a global change across the whole economy and part of the macro-level for sociotechnical transitions (Rotmans and Loorbach 2010). It is noteworthy that these developments take place in all sociotechnical systems.

In service research disciplines, in turn, both the role of technology in services and the role of services for innovation and technological development have been investigated. Service innovation studies were developed particularly from the 1990s onwards (Coombs and Miles

2000; Gallouj and Savona 2009; Carlborg et al. 2014). Investigations include analyses of service activities, companies, and the evolving service sector. Attention has been drawn to the specific characteristics of services, non-technological innovations, as well as the more general influence of service innovations on business development and technological change (Gallouj and Weinstein 1997; Sundbo 1997). The studies have examined how services or certain service industries, such as KIBS, evolve, and what takes place in company operations in the markets, that is, in service firms, in manufacturing firms, as well as any organization providing services to its customers (Miles 2016). Services, particularly KIBS, have been emphasized as being important for innovation systems and service innovation is essential to include in industrial policies (den Hertog and Rubalcaba 2010).

Figure 2 depicts service trends as an evolving landscape of sociotechnical systems. MLP examines the sociotechnical system changes with a particular focus, such as energy or mobility systems. System changes take place within broader socio-techno-economic developments across several sociotechnical systems (upper part of Figure 2). These developments of the sociotechnical landscape include long stable development phases illustrated with gradual incremental changes, and short turbulent phases of technological discontinuities. Service trends (grey arrows), such as servicification of the economy at a macroeconomic scale, servitization of the manufacturing industry, or the changes in company strategies and operations depict structural changes, i.e., a shift between system elements. Service trends are gradual changes of the broader socio-techno-economic landscape, and they can be detected in all sociotechnical systems.

Regime change of a particular sociotechnical system, and the service trends across several sociotechnical systems are distinct but overlapping perspectives of the changing operating environment of the forest-based sector.

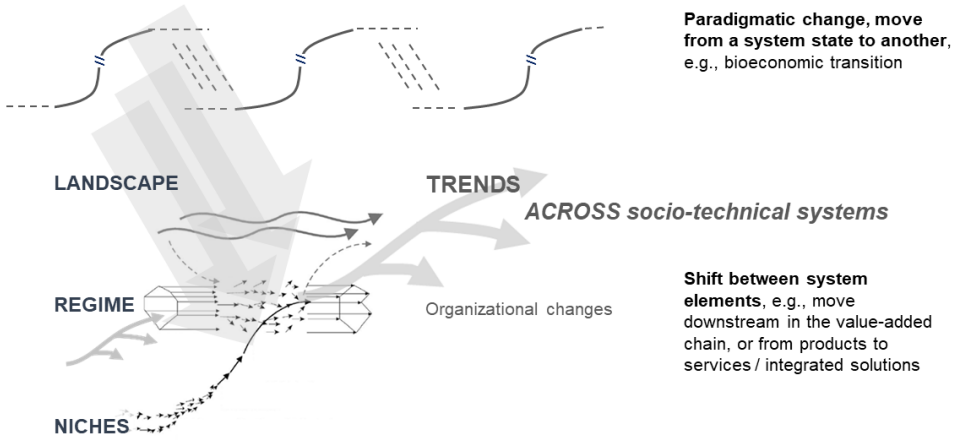

Figure 2. MLP on sociotechnical change and service trends as the evolving landscape of sociotechnical systems (own illustration, MLP, on the left, based on Geels 2005, p. 685).

Dynamic balance of rulesets in the sociotechnical regimes

A regime is a central concept in MLP. While individuals and organizations are constrained by the system in which they operate, they also continuedly enact and shape the system and its rules (Geels 2005). Along with the neo-institutional theories, MLP understands institutions as processes (Geels 2020). Building on Scott's (1995) three pillars of institutions, Geels (2004) defines that social stability and institutional change are outcomes of the alignment of the regulative, normative, and cultural-cognitive rulesets. These include the formal coercive rules and laws; normative pressure of values, role expectations and duties, and the taken-for-granted meanings and frames, including artefacts and symbolic processes (Scott 2014).

Furthermore, Geels (2005) defines sociotechnical systems and regimes as organizational fields that guide social actors toward homogeneity and collective rationality (DiMaggio and Powell 1983). The sociotechnical systems consist of several interacting groups: engineers developing the technology, but also the finance, various suppliers, production, users, consumers, research, public authorities, and societal groups, such as, NGOs and media. On one hand, these groups have relative autonomy and their own selection environments, and, on the other hand, they share the dominant trajectories in the sociotechnical systems (Geels 2005). There is a dynamic balance between the rulesets of the regime. When the rulesets are sufficiently aligned, the system is stable and the established sociotechnical regime is more solid and able to maintain gradual changes, make adjustments to niche innovations, and mitigate the tensions of the exogenous landscape.

Table 1. Rulesets of sociotechnical systems as a basis for detecting service trends (own elaboration based on three pillars of institutions in Scott 2014, p. 60).

Rulesets / institutions	Regulative	Normative	Cultural-cognitive
Basis of order	Regulative rules (what are monitored as services)	Binding expectations (what is expected from services or as a service)	Constitutive schema (what are understood as services or as a service)
Mechanisms	Coercive	Normative	Mimetic
Logic	Instrumentality (getting things done)	Appropriateness (doing proper things)	Orthodoxy (the way we do things)
Indicators	Rules, laws, sanctions, standards	Certification, accreditation, obligations, expectations	Common beliefs, shared logics of actions, sensemaking frames, incl. artefacts

Table 1 summarizes how service trends can be detected based on the rulesets, and semi-coherent configurations of sociotechnical systems. Services are instrumental for sociotechnical systems. Service trends become visible when monitoring the target system based on formalized rules, such as macroeconomic standards (services vis-à-vis other economic activities), or on a company level the market transactions as defined in contracts between the producer and customer. Regulative rulesets are slow to change. The statistical classification systems unavoidably lag behind new services enabled by technology, new configurations or new ideas tested in the markets (Miles et al. 2018). Changes of contracts between companies, in turn, can be negotiated at a quicker pace. Rolls Royce is an often-mentioned example for servitization (Baines et al. 2007); instead of selling an engine for an aircraft, in the 1960s the manufacturer developed engine maintenance management and started to lease "power by the hour". The example is illustrative of one of the product-service system categories and how change in the manufacturing industries in general can be assessed.

In other words, while changing configurations in a system can be challenging to capture with established standards, qualitative categorizations have been developed to describe the changing normative rulesets and the logic behind market operations. For example, these categorizations can be used to describe what is appropriate in terms of task division between a producer and customer, how products and services are bundled into market offerings, or how the business model of a product-oriented firm differs from that of a service-oriented firm in an industry. These illustrate different dimensions of service trends which have been identified and further elaborated by the service research disciplines.

Overall, service research provides information on changes in several sectors of economic activity. The understanding on as well as the means to capture and assess service trends have accumulated over the decades in different research disciplines. The empirical studies and conceptualizations developed in these disciplines describe gradually changing grammars of how companies operate in the markets and orientate in their operating environments, and deal with technological change as well as changing regulations and policy targets.

Service research in business studies stems back to the 1970s, starting in the marketing discipline and the analysis of service firms to draw managerial implications to develop new or better services. Services both as activities, products and processes were first investigated in the service firms, and then overall, in any type of organization or in any actor-to-actor interactions (Fisk and Grove 2010; Gummesson and Grönroos 2012). Investigations on service firms brought attention to the distinct features of service provisioning, for example, the interaction between the service provider and user, and the role of customer experience in assessing service quality (Parasuraman et al. 1985; Zeithaml et al. 1985). Service innovation research, for its part, elaborated how the broad characteristics of service innovation are applicable both to the services and manufacturing industries (Gallouj and Weinstein 1997). Sundbo (1997) described this understanding on innovations along a service-professional trajectory; technology is just one element of innovation, while interactions and the intra- and inter-organizational learning are distinctive in services. Carlborg et al. (2014) outline the chronological development of research on service innovation from mere product innovation to the particularity of services, and further, to an integrated approach to both products and services, and from intra- and inter-firm interactions to wider system levels. Instead of an analysis on dyad or network relationships, today, marketing management researchers call for attention to business environment evolution (Möller et al. 2020) and emergence in service ecosystems (Vargo et al. 2023).

Servitization in manufacturing, in turn, was defined in the late 1980s as a question of service operations management (Vandermerwe and Rada 1988). Servitization, or the

bundling of products and services, was examined both in terms of strategic management and engineering. Currently there are several engineering disciplines elaborating these themes, for example in sustainability design and environmental engineering of product-service systems (Mont 2002), operations management (Baines et al. 2007), as well as information systems engineering (summarily in Boehm and Thomas 2013). Here services as such are not the target of analysis, but rather, management and engineering of the increasingly complex Product-Service Systems (PSS). PSS are developed both as intra- and inter-firm operations, and solutions are investigated for the broad functional economy targets (Tukker 2004) as well as for company competitiveness (Cusumano et al. 2015).

These research fields exemplify how the changes ongoing in the markets have been analyzed, and which concepts have been defined to capture the changes, and to some extent also to direct them toward improved competitiveness, efficiency and/or sustainability. Analyses of company operations in markets have observed several directions in these service trends. For example, instead of a mere shift from products to services, product-oriented companies make several turns (Kowalkowski et al. 2017), simultaneously apply different strategies to different products, customers, or contexts, as well as experiment with open business models to extend service business either internally or through outsourcing (Visnijc et al. 2018). The product-orientation vis-à-vis service-orientation are not exhaustive categories to capture these ongoing changes. Furthermore, directing PSS development in markets has several implications. While PSS can be designed for sustainability, the outcome is not necessarily improved sustainability, but other benefits which, in turn, may result in negative environmental impacts (Tukker 2015). Product Service Systems do not lead to the outcomes they were designed for. Furthermore, bundling products and services into 'operations without operations' illustrates automated systems applicable to any system definitions and for several goals in parallel (Breidbach et al. 2018). Service trends are part of the continuous ongoing configurations in sociotechnical systems. They can be assessed as part of the lock-in as well as lock-out mechanisms of the sociotechnical systems.

Service trends at multiple scales of organizational change

As described in the previous examples, services are an ambiguous target for analysis. Yet, the service research disciplines collect evidence on the ongoing changes, and conclude managerial implications for companies and organizations. In the service research emphasis is given to the definition of service both as product, process, and outcome (Miles 2016). The service research disciplines make an explicit distinction between services (*plural*) and service (*singular*). Here services refer to activities, outputs, or products exchanged in the markets, and service refers to process qualities and outcomes. Services are something quantified/quantifiable, while service as a quality characteristic is more difficult to measure. Service quality necessitates assessment by the user or beneficiary, which is affected by several factors beyond the control of the service provider (Vargo and Lusch 2004; Grönroos 2006). Additionally processual changes include learning, which illustrates changes in intra- and inter-firm tasks, roles, and practices (Sundbo 1997; Toivonen and Tuominen 2009).

These concepts illustrate the multifaceted phenomena related to service trends, and the challenges in capturing their impact. However, service research knowledge bases provide several angles on the intra- and inter-organizational changes in the markets: what has taken place in the company operations or interaction of multiple companies in a particular context,

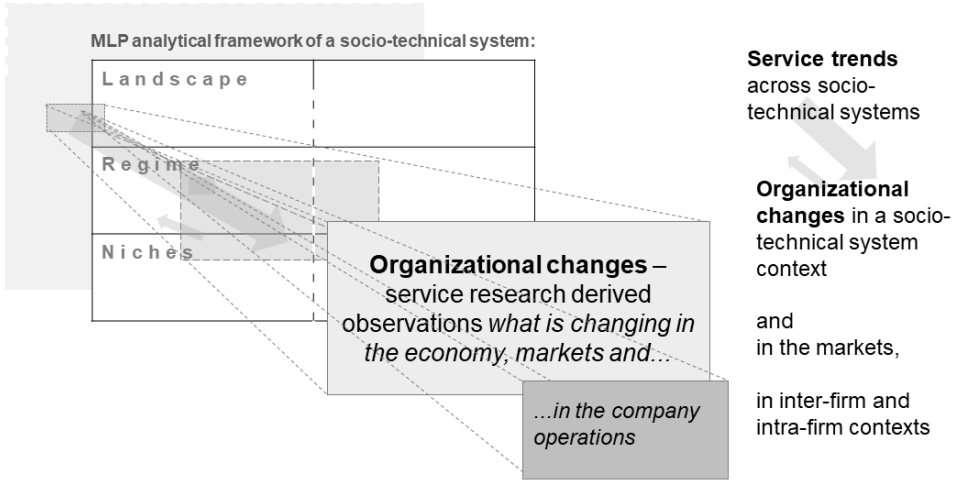

Figure 3. MLP as a device to detect service trends at multiple scales of organizational changes ongoing in the operating environment.

or organizational field, and further, how such observations have been produced into categorizations to assess the direction of change(s) on the scale of an economic sector, such as manufacturing or KIBS, more generally in the markets, or overall in the economy.

Figure 3 shows how MLP can be used as device to detect service trends in the operating environment and think through implications of these changes for the forest-based sector. This research purposefully adopts a flat system ontology to system change. Service trends are part of the evolving sociotechnical landscape, and they are detectible as the organizational changes on multiple scales within and across the sociotechnical systems.

Service research knowledge bases provide to gain more depth to sociotechnical system change. The evidence bases collected in service research are contextual, i.e., based on the empirical observations and analyses made in a particular industry or system/subsystem context. Analyses can focus on a specific industry, such as manufacturing industries or KIBS firms, and/or investigate an individual company, dyad of a service provider and user, network, or a wider service system. With its focus on a sociotechnical function, the MLP analytical framework is at a higher system level than the service research investigations on company operations, but at a lower system level than the gradual changes of markets, illustrated, for example, by servitization in manufacturing. Detecting service trends as empirical phenomena extends from a mere analysis of the past developments to the diverse contexts where gradual changes of sociotechnical systems take place.

With the analytical framework, service trends can be defined as targeted cases for analyzing individual organizations, groups of companies, sub-groups, or subsystems of the sociotechnical system, and connecting the empirical observations to a broader sociotechnical transition—as here: assessing service trends in the context of the forest-based sector and bioeconomy.

METHODOLOGY

This section describes the research design, data and methods applied in the three empirical studies. Service trends are assessed as the evolving sociotechnical landscape, and the service research disciplines provide the knowledge base and evidence on the ongoing organizational changes in the operating environment of the forest-based sector.

Research design

The three empirical studies conducted in this research seek to capture service trends as a multifaceted phenomenon observable in the forest-based sector and its operating environment. The forest-based sector itself is an evolving concept (Näyhä et al. 2015). On one hand, it includes the traditional forest sector, whose industries connect with an increasing number of other related industries, such as the supply industries of machinery, chemicals, and engineering, but potentially also with new customer industries, such as textiles. On the other hand, the forest-based sector also includes versatile other forest-based activities, which are given a more visible role in the bioeconomic context, such as recreation, health, and environmental services. The forest sector consists of primary production including the natural resources management, multi-purpose use forestry and supply of raw materials, the processing and manufacturing industries, (on the economic activity standards the NACE Rev.2 Sections A02 Forestry, C16 Manufacture of wood and of products of wood and cork, and C17 Manufacturing of paper and paper products), as well as the forest-related activities and employment in government, administration, research, and education (Forest Europe 2020).

In MLP terms the forest-based sector is an industrial subsystem which supplies raw materials, interim products and solutions for energy, mobility, housing, and other sociotechnical systems. The definition, thus, is closer to the traditional forest sector than the evolving bioeconomy conceptualizations. However, this definition allows studying the forest-based sector in several contexts of sociotechnical change by using MLP as the analytical framework.

Table 2 summarizes the three empirical studies with the MLP analytical framework. While the three studies were published in peer-reviewed journals as independent research, in practice the research proceeded as successive stages of analysis: Article I assessed the role of services across industrial sectors, and it led focusing the attention to business changes; Article II scrutinized the shift from a PSS business model to another, and its findings highlighted the role of non-technological innovations in industrial processes; and Article III examined service innovation as part of the evolving PSS, which, in turn, brought the different scales of sociotechnical system change to the fore. Although this may sound a straightforward process in elaborating both the multiple levels and scales of sociotechnical change, in reality the process was not linear. Typical for phenomenon-driven research, the research remains open during the course of investigations to be modified as needed, and even changed, due to emerging questions (Schwarz and Stensaker 2016).

Table 2. The empirical studies (I-III) with the MLP analytical framework to detect service trends.

MLP analytical levels	I	II	III
Landscape/service trends	Increasing role of services	Servitization in manufacturing	Evolving Product-Service Systems (PSS)
Indicators to detect service trends	Services and service	Economic activity standards (NACE)	Role configurations
Organizational changes (incl. categories derived from the service research)	[strategy orientation in an industry]	PSS business models, activity systems changes	Service innovations in evolving PSS, and changing market offerings, value propositions
Sociotechnical regime	-	Industrial construction	Housing construction
The forest-based sector context	Forest-based sector & RDI in Bioeconomic industries, Processing, Manufacturing, Energy efficient buildings, and Vehicles	Supply networks, incl. wood industries among other suppliers	Construction projects, incl. material, product, and solution suppliers among other construction project tasks
Niches	-	Wood construction	Sustainable housing, incl. wood construction, energy efficiency, resource efficiency, green infrastructures, and social /communal solutions

Consequently, the three study contexts exemplify different system boundary definitions for assessing the forest-based sector and its change in Articles I-III:

I. "Services in the forest-based bioeconomy – analysis of European strategies" included the strategic partnership sectors indicated in the EU-level forest-based sector strategies and the technology platform's strategic agendas. The starting point for the analysis was the forest-based sector and the study examined how to assess the increasing role of services in the forest-based sector vis-à-vis the technological platform, and the close-by strategic sectors in the EU.

II. "Servitization and bioeconomy transitions: Insights of prefabricated wooden elements supply networks" was based on confidential business data on three wood element products. The starting point for the analysis was industrial construction as a customer of the wood industries. The study examined how servitization affects the evolving bioeconomy, or more precisely, which business model changes can be detected in the manufacturing supply networks around the forest-based industries.

III. "Service innovation and sustainable construction: analyses of wood vis-à-vis other construction projects" included eight sustainable housing projects which were identified via convenience sampling to find comparable cases, i.e., projects of similar size realized in approximately the same time. The starting point for the analysis was sustainable housing construction, thus, the wood construction supply networks were assessed among other solution providers in the markets. The paper

explored how evolving PSS affect the complex product systems of construction, or more precisely, which service innovations can be detected in the markets where the forest-based industries operate.

Indications of service trends, i.e., the standards and categorizations of organizational changes, were defined for each study separately based on several disciplines (see also Table 3 on data and methods). In Article I the basis for assessing the role of services in parallel sectors was the distinction between services and service which had been made explicit in service research disciplines. In Article II changes in industrial supply networks were assessed with production economics tools to capture intangible value creation, and the operations management categorizations on product service systems to describe the business model change (Baines et al. 2007; Neely 2008). In Article III generic service innovation research categories were used to elaborate evolving PSS and the assessment of market changes was further scrutinized with the assistance of marketing management categorizations on value propositions (Payne et al. 2017). The synthesis of the three studies builds on the MLP analytical framework.

The categorizations chosen to detect service trends in a particular research context are illustrative to the ways of assessing services as a multifaceted phenomenon in the forest-based sector's operating environment. As such, the purpose of this research is not to explain the operating environment changes, nor justify one approach over another for such analysis. Instead, MLP has been used as an analytical tool to systematize information on service trends and their implications for the forest-based sector.

Data and methods

Table 3 summarizes the data and methods in the three studies. Excluding confidential business data on supply networks in Article II, the data were sourced from publicly available documents, websites, international and national company databases, and online registers. The main method for analyzing the textual data is a qualitative content analysis: in this respect Article I is a review of strategies and RDI roadmaps, Article II is an analysis of business descriptions of companies, and Article III consists of analyses of both the project descriptions and individual companies' market offerings.

In addition to these aspects, Article II analyzed three wood element products with a value-added trade analysis, a method developed to assess the international distribution of global value chains. Although services are not measurable as a precise volume or proportion of activities in the manufacturing industries, intangible value creation describes services embedded in all economic activities, thus, also within the wood industry value networks.

In addition to these aspects, Article II analyzed three wood element products with a value-added trade analysis, a method developed to assess the international distribution of global value chains. Although services are not measurable as a precise volume or proportion of activities in the manufacturing industries, intangible value creation describes services embedded in all economic activities, thus, also within the wood industry value networks.

The value-added trade analysis replicated the method used in the studies conducted by the ETLA Economic Research for different types of products and services (Ali-Yrkkö 2013; Ali-Yrkkö and Rouvinen 2015). The bill of materials was the basis for identifying successive tiers of production, i.e., the list of materials and components used in a manufactured wooden element including details on suppliers and prices. In addition to this, further information was also sought from the three companies, as well as by contacting the first-tier suppliers directly.

Table 3. Data, methods and knowledge bases in the three empirical studies.

Empirical context	Data	Methods	Knowledge bases on service trends
I Services in the forest-based bioeconomy – analysis of European strategies	Documents from forest and bioeconomy strategies, and EU Horizon 2020 RDI roadmaps of FTP, and bioeconomy, processing industries, manufacturing, energy-efficient buildings, and green vehicles	Review, qualitative content analysis	Services and service research (generic from service sector economic and innovation research, marketing research, business and strategic management research)
II Servitization and bioeconomy transitions: Insights of prefabricated wooden elements supply networks	Supply network data of 3 wooden elements from three companies; Company financial data from international company databases and national registers	Value-added trade analysis (distribution of value; identification of companies in the successive tiers of supply networks)	Production economics: research on global value chains (Ali-Yrkkö and Rouvinen 2015)
	Company (N=120) business descriptions in international company databases and national registers (company websites as additional data sources)	Qualitative content analyses	Operations management: PSS categories (Baines et al. 2007; Neely 2008); Business models as activity systems (Zott and Amit 2010)
III Service innovation and sustainable construction: analyses of wood vis-à-vis other construction projects	Project descriptions/publicly available data on 8 sustainable housing construction projects	Qualitative content analyses (identification of companies; PSS and service innovations)	Service innovation research (generic, summarily by Coombs and Miles 2000; Gallouj and Savona 2009)
	Company (N=89) marketing communications from the company websites (company databases and registers as additional data sources)	Qualitative content analyses (identification of PSS and service innovations, assessment of value propositions); Thematic analysis across the analyzed datasets.	Marketing management: Value proposition categories (Payne et al. 2017)

The value-added trade analysis replicated the method used in the studies conducted by the ETLA Economic Research for different types of products and services (Ali-Yrkkö 2013; Ali-Yrkkö and Rouvinen 2015). The bill of materials was the basis for identifying successive tiers of production, i.e., the list of materials and components used in a manufactured wooden element including details on suppliers and prices. In addition to this, further information was also sought from the three companies, as well as by contacting the first-tier suppliers directly. The value added of each supplier company was approximated by using value-added margins and was further divided geographically based on the supplier company information. The

resulting observations on the international business structures of the supply network were tested and clarified in interviews with industry federation representatives who also provided expert views on the trends in specific supply industries. Product-wise analyses were presented as relative shares of the geographical distribution and production stages, corresponding to the level of detail in the studies conducted by the ETLA Economic Research. Article II also briefly concluded the findings concerning industrial wood construction vis-à-vis the previously analyzed cases.

A major contribution of this research step, however, was that it directed attention to the real-life value networks as a particular research context for service trends in sociotechnical systems. Rather than a mere question of value distribution internationally, the blurring of economic activity categories in the supply networks emerged as a more targeted question for further scrutiny.

Mixed methods are typical for pragmatic studies, thus, choosing the best method for the purpose. The research questions and procedures are considered in each step of the inquiry: what motivates the research, and what the procedures are to meet those goals (Morgan 2013). In phenomenon-driven research the challenges encountered, new questions and perspectives emerging during the research can lead to new openings. In this research, such a turning point was the deeper analysis on business models in Article II. After the value-added trade analysis, data on all companies identified in the three supply networks were assembled into one dataset and organized into economic activity (NACE) categories.

The same analytical design was repeated in the successive study. Furthermore, Article III analyzed real-life value networks, but the companies were identifiable in the publicly available project descriptions and marketing materials. The eight projects were first analyzed separately, and all companies identified were then assembled into one dataset. The dataset was categorized according to the construction project tasks, thus, the analysis extended to the established roles in the construction regime.

In all studies the textual data were analyzed to identify, describe, and exemplify service trends with the chosen indicators of organizational changes. Hsieh and Shannon (2005) define three approaches of content analysis as analytic methods for textual, visual, and other datasets, where both quantitative and qualitative analysis can be applied. In an inductive approach, or a conventional qualitative content analysis, keywords/codes are derived from the data to produce a thematic analysis and to conceptualize latent knowledge. A deductive approach uses pre-defined codes for theory-driven analysis to confirm or test a theory, or like in this study, to expand the understanding of a phenomenon. A summative approach, in turn, produces a quantification of a specific content via keyword counting. A thematic analysis, thus, is a qualitative data analysis to identify, organize and interpret themes in textual data. It can be used as a generic approach (type of analysis) or as an integral part of a wider methodology, such as, grounded theory (King and Brooks 2019). This research applied a generic approach to the thematic analysis.

Krippendorff (2019) argues that the distinction is artificial between quantitative and qualitative content analyses: a content analysis is always interpretation which involves making inferences from the text to the contexts of their use. An algorithm-assisted analysis is based on a qualitative assessment when developing the research design, testing, and when instructing the procedures. The in-depth qualitative analyses in turn contribute to a broader scale analysis by exploring and defining the concepts necessary in analyzing large datasets. For a content analysis to be replicable, clear instructions for interpretations are needed, including explicating the context that guides the inferences (Krippendorff 2019).

This research emphasizes the qualitative, interpretative nature of the content analyses made: the research approach in all three studies is explorative and aims to detect service trends, describe organizational changes with concrete examples, and discuss the findings vis-à-vis the forest-based sector context, including bioeconomy developments. Articles II and III both analyzed approximately a hundred companies, categorizing the companies into smaller groups, which structured the analysis toward an in-depth assessment for each sub-group separately, rather than organizing and coding of large datasets. Furthermore, although pre-defined tools for interpretation, transparent processes and objectivity of analyses were sought, the relation between the data and analyses was explorative.

The pre-defined categories from service research gained more detail with the examples of services and/or PSS. In individual studies, this led to checking the observations with other parts of the datasets, and as needed, to extend illustrative examples for the whole company dataset. For example:

I. The points which were challenging to categorize with the predefined codes were cross-checked across the dataset and discussed with the team of authors. For example, 'services to society', 'benefits', 'users/beneficiaries' were identified for cross-checking through the whole dataset.

II. When compiling the company dataset, the database descriptions, especially for the small and medium-sized companies lacked detail for PSS. The whole dataset was cross-checked with the company websites for descriptions of products, service and/or solutions supplied for the case products. This complementary data clarified the inconsistencies found, for example in terms of what the suppliers do or which roles subsidiaries play in the supply networks. Additionally, interviews with company representatives, suppliers, and industrial federations were used to triangulate data and verify the conclusions formed from the analysis.

III. Datasets for projects and companies were analyzed for concrete examples of service innovations as well as different types of value propositions. Services as outputs, inputs and processes formed the basis for detecting service innovations, and the questions of what, who and how guided the assessment of value propositions. Thus, rather than precision, the analysis targeted illustrative examples of evolving PSS. Company databases and registers were a means to triangulate the data from company marketing materials (incl. business descriptions, but also RDI project financing). As a final step, the examples collected both from the projects and company data were scrutinized in a thematic analysis by clustering the examples to identify recurrent patterns in the data. While the PSS literature already indicated purposive changes as themes to describe the evolving PSS, such as improved competitiveness or efficiency, also other patterns emerged. These are described in the findings as potential disruptions embedded in evolving PSS.

Following the pragmatic approach, as applicable, a quantification of results was also carried out to compare industries, and for example, assessing the relative share of sample companies in each category. However, the quantifications describe only the cases analyzed and should not be generalized to wider target groups or other contexts.

RESULTS

This section describes results of the three empirical studies and presents a synthesis of the implications derived from them for the forest-based sector.

Service trends: services, organizational changes and the potential for system change

Table 4 summarizes the studies on service trends in I) the forest-based sector vis-à-vis its strategic partner industries, II) industrial wood construction, and III) sustainable housing construction. The categorizations derived from the service research disciplines can be grouped under three headings of organizational changes detectible in the operating environment. Firstly, service trends are captured by assessing changes in services, thus, the market transactions of service inputs and outputs. Secondly, service trends can be assessed through their qualitative process characteristics, thus, including how roles and tasks are redefined in the interactions of providing service. Thirdly, service trends can be assessed as the potential for system change embedded in the changing sociotechnical systems, thus, the services and service provisioning enabled by technology, but at the same time, enabling technology adjustments and dissemination.

Table 4. Summary of the categorizations used in the three empirical studies to detect service trends and assess related organizational changes.

		Services as inputs, outputs, and processes/solutions	Service as qualitative process characteristics	System change potential
I	Increasing role of services	Non-production activities and non-products (transactions/ services for fee) “services separately”	Strategic orientation of the company operations (value creation/interactions); “service-orientation to understand the customer needs”	- [evolving bioeconomy]
II	Servitization in manufacturing	Business model change: extension of the tangible product to the customer as integration-, product- or service-oriented PSS	Business model change: extension of the company operations to/within the customer processes as use-oriented or result-oriented PSS; “co-production of solutions”	Integration infrastructure, attention to system dynamics, incl. non-technological innovation
III	Evolving Product-Service Systems (PSS) in the markets	Service innovations, either new service outputs, inputs, or processes in PSS; pre-determined value propositions	Changes in market offerings indicating service innovation as change potential in PSS as the new feedback loops, capacities, and contexts; from transitional to mutual value propositions and “co-creation of value”	Changing practices and de/re-configurations in the markets, attention to emergence and open outcomes

Services in the RDI roadmaps of industrial systems

Article I assessed the forest-based sector strategies and the European-level bioeconomy and strategic partnership RDI visions and roadmaps: the services identifiable in the parallel sectors' technological development directions and resource allocations for research and development provide a point of comparison for the forest-based sector. Services are defined as 'intangibles', i.e., the activities separate from primary production and manufacturing–processing and the outputs separate from tangible products. Service in turn is defined as strategic choice for value creation and for business model development. The key finding is that although services were part of the development agendas in all of the RDI roadmaps analyzed, the forest-based sector and bioeconomy strategies tend to assess services as support functions to industrial production, while the strategies of the process industry, energy-efficient building sector, manufacturing, and green vehicles also recognize services as new service business opportunities inherent to industrial development. For example, environmental accounting and climate change mitigation services as a business opportunity gained more attention in the other strategic partnership RDI roadmaps than in the forest and bioeconomy strategies.

The study discusses manufacturing logic vs. service logic—or as Vargo and Lusch (2004) define it, goods-dominant vs. service-dominant logic—as the two analytic frameworks from the service research disciplines to describe the changing approaches to value creation: enabling technologies allow closer interaction with users and beneficiaries, and the design of solutions by leaning on the user/beneficiary resources and processes. The forest-based sector strategies highlight services to society, i.e., the benefits of the ecosystem services by forests and the sustainable management and use of these resources. These services are part of the industrial production value chains, but they remain at a broader societal level than the services illustrated in the strategic partnership RDI roadmaps.

The study concludes two distinct lanes of investigation for analyzing the increasing role of services in the context of evolving bioeconomy: 1) explicating the role of services in the bioeconomy supply chains in order to improve efficiency and the existing processes, and 2) elaborating service as a means to better understand the changing business models and modes of value creation which may lead to system-level changes.

Servitization and increasingly integrating industrial production systems of construction

Article II further scrutinized the modes of value creation and elaborated the increasing role of services in changing business models. The PSS business models identifiable in the industrial construction supply networks indicate a source of renewal for wood industries due to the spillover of both technological and non-technological innovations across industries. MLP is used as an analytical framework to assess servitization as the organizational changes in individual companies, in the supply networks and at the level of industrial production system. Key findings are two-fold. Firstly, the global servicification development and the increasing international distribution of production tasks in the global value chains is challenging in the context of industrial wood construction. The largely domestic and regional supply networks for construction illustrate activity systems that are market specific. Moving downstream in the value-added chain as a strategic choice to servitization would limit the options of forest industry companies that seek large-volume international markets. Secondly, the PSS business models are identifiable in all industries involved in the supply networks. Assessing servitization developments solely in the manufacturing companies restricts the

view on market changes; the evolving digital systems, information infrastructures and data-as-a-service offerings exemplified in the supply networks describe an increasing integration across manufacturing, services as well as primary production. Moving upstream of the value-added chain, such as to new bio-based raw materials produced by the forest industries, involves the service infrastructures already developed in the industrial production processes.

The study discusses how servitization, as a gradual reconfiguration in production systems, at the same time maintains and disrupts the established regimes. In addition to a point of comparison between the forest-based sector and other sectors, servitization provides a perspective on the system dynamics of the construction sector, renewal of wood products companies, as well as the evolving bioeconomy. Focusing on the existing products and production modes—such as the efficient material supply, or the wood industries moving downstream in the value-added chain—serves as a means to maintain the established construction regime and its gradual change. Simultaneously, technology-enabled integration of production processes already enables rethinking value creation and capture, extending the value potential of the forest-based sector across the whole industrial construction system, thus, also to the real estate sector and to users/beneficiaries. An example of the ongoing changes are the intermediaries in trade and logistics: while their role in the construction supply networks is partly decreasing due to the products and materials available in the manufacturers' online systems, they seek to provide information as a service. The information attached to the materials and products enables an efficient flow of resources, transparency of operations and verification of compliance with standards. But more so, digital tools and digital products allow companies to develop efficiency throughout the whole construction life cycle and beyond to reuse and recycle of the products and materials. Redefining the value potential from sustainable production requires reverse thinking and disrupting the established regimes: paradoxically, instead of thinking of advanced services as a move downstream in the value-added chains, servitization could also lead to higher attainable added value by moving upstream in the value chains.

Evolving product-service systems in the markets of sustainable construction

Article III further scrutinized the system dynamics due to service developments and elaborated changing value creation in evolving PSS. The service innovations identifiable in the sustainable housing construction markets exemplify the system change potential inherent to PSS as new service outputs, input from the service companies, and changing processes. Here attention is no more on wood construction solely, nor manufacturing servitization as in Article II, but several types of PSS for sustainable housing solutions, including wood as well as resource efficient, energy efficient, communality development, and green infrastructure construction projects. With the assistance of the MLP framework, the data analyses connect the empirical observations about company market offerings, the configurations developed in construction projects, and the construction system change. The study discusses the evolving PSS for the potential system change in construction in general, and regarding wood-based solutions in particular. The key findings are that similarly to other sustainable housing construction projects, wood-based solutions bundle products and services into solutions and seek to create efficient industrial processes which are based on evidence of sustainability performance of the technical infrastructures. Analyses on service innovation and value propositions, however, illustrate that the wood-based solutions aim at industrial efficiency in the established construction processes, while the parallel sustainable construction projects and the contributing companies exemplify more versatile service innovations. Examples

include experimentation on how ecological and social functions become part of the technical infrastructure solutions, and how smart city solutions extend from housing to energy, mobility, local services, and to climate-smart future living concepts.

The system change potential of evolving PSS in the construction sector is more profound than mere material substitution in the existing construction processes for the established regime. Bundling the 'tangibles' and 'intangibles' illustrates how evolving PSS redefine the accustomed system boundaries and challenge the established business models: for example, electrical installation companies offer electricity as a service, or a supplier of solar energy systems offers cloud services and mobile applications for users to accumulate the necessary market data in support of possible regulation change. Both examples illustrate how companies create the necessary means to enable the market growth of new solutions. In addition to production efficiency, more open business models are able to experiment with organizing the functions of the built environment anew. Resident service providers but also the residents themselves operate using the digital platforms of rental housing companies. Paradoxically, thus, increasing integration leads to new de/re-configurations of tasks. Standardization due to fine-granule modularity and customization in turn leads to increasing diversification. Residents are no more final users and consumers of the sustainability solutions offered to them but also contributors and service providers of peer-to-peer platforms. These empirical observations demonstrate that none of the PSS models alone capture the future PSS, as perceivable in the designs for resource integration, greater efficiency, improved sustainability, advanced digital systems, or smart functionalities. Alternative scenarios should be investigated and their impact assessed on wood construction and the forest-based sector operations.

Implications for the forest-based sector and evolving bioeconomy

Examples of service trends collected in the empirical studies provide detail on the evolving sociotechnical landscape. While the outcome of the sociotechnical change remains open, the empirical studies complement each other in assessing service trends and their implications in the operating environment. The value-added chains of the forest-based sector and its strategic partners are part of the value networks of the increasingly integrated industrial production systems of the construction sector, and both are examples of the ongoing changes in the markets: how companies seek to maintain and improve their competitiveness, how they operate in interaction with other market players in order to benefit from the emerging opportunities, for example, by adopting and adjusting new technology in their operations. These changes are ongoing. However, they unfold differently for the forest-based sector depending on the system boundary definition chosen when analyzing the operating environment.

To assess the implications of service trends for the forest-based sector, Figure 4 shows the three system boundary definitions used in the empirical studies. The linear value-added chain (lower part of Figure 4) illustrates the intra- and interorganizational changes in the forest-based sector organizations. Assessing changes in services, i.e., the transactions of inputs and outputs, directs attention to structural changes in the forest-based sector, such as the forest-based industries adding services to their products to remain competitive, or providing the services necessary to support the renewal of the forest-based sector. In terms of the MLP analytical framework, these are changes in subsystems within a sociotechnical system. The ascending arrows, in turn, illustrate the changes in the construction regime.

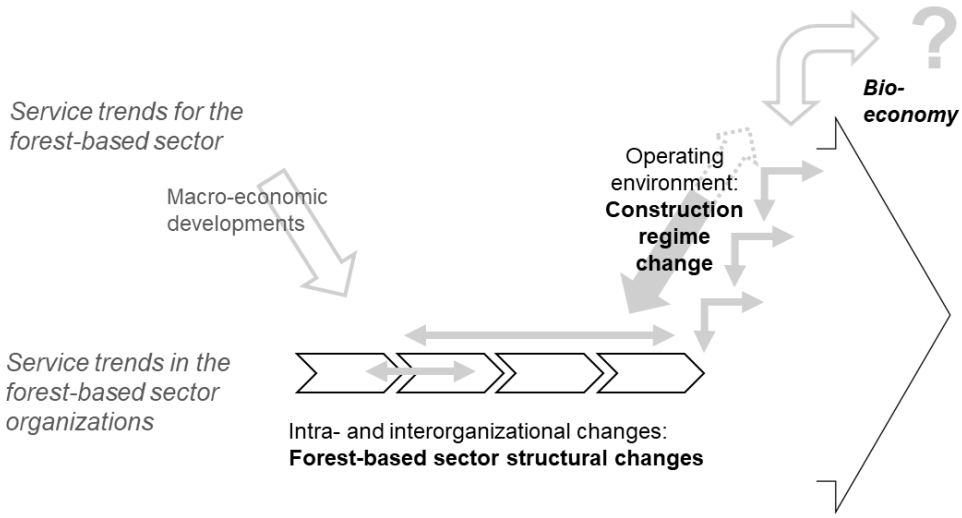

Figure 4. The three empirical studies provide complementary perspectives on service trends.

Assessing processual changes and interactions within the supply networks reveals how the customer industry and its processes are changing. The question mark indicates discontinuities of broader socio-techno-economic system change. The assessment of service innovation and changing PSS market offerings directs attention to the system change potential embedded in the sociotechnical systems.

With concrete examples, the empirical studies demonstrate that service trends are challenging to capture within the forest-based sector value-added chains solely. The support services in the forest-based sector are already recognized as new business opportunities in other industries, for example, as environmental accounting and climate change mitigation services for engineering, manufacturing and processing industries. For improving efficiency of the forest-based sector value-added chains, Article I concludes that it would be important to utilize the service research and service innovation conceptualizations to support the realization of the forest-based sector goals. For industry success, a crucial question is to understand the customer process beyond the b2b contexts, thus, further downstream of the value-added chains.

An analysis of how value networks are organized and how services contribute to the system dynamics in the construction sector shows that while the forest-based industries focus on efficient, transparent processes to serve the existing production systems, there are more profound experimentations identifiable in the construction supply networks, as well as by the customers and users of the forest-based sector solutions. Articles II and III detect the new infrastructures which are forming out. There are digital tools to integrate upstream and downstream of the value-added chains in novel ways. As-a-service platforms involve service providers and users, thus, interactions between companies and consumers/residents, as well as peer-to-peer activities of users and beneficiaries. In order to benefit from the increasing integration of industrial production systems in wood construction, Article II discusses the need for better understanding of the non-technological innovations along with the technological change. Co-producing solutions in the sociotechnical system of construction could open the possibility, for example, to connect the wood construction supply networks

and the emerging bioindustries anew. Instead of mere efficient biomass material flows attention could focus on the organizational changes ongoing in the supply networks. The new service infrastructures enable increasing efficiency for several functions of the built environment, including technical performance as well as the solutions for social and environmental sustainability. Article II asks: How can the wood products companies serve those customer processes that ensure their own success in a changing construction system? What does wood provide for the customers, real estate sector and users beyond the present-day solutions in the built environment? Wood products industries, their supply chains, and the sustainable forest use as a production system serve several functions for the increasingly integrating industrial systems. Co-production of solutions takes place on multiple scales of transitions, across individual companies, supply networks and sociotechnical systems.

An analysis on the evolving PSS examines how value is proposed to be defined, created, delivered, distributed, and captured in company interactions, and reveals the de/re-configurations ongoing in the markets. Servitization unfolds as a systemic change, where accustomed system boundaries and the established business models are challenged. From the perspective of evolving markets, Article III emphasizes the need to understand the parallel PSS already developed. This could be done by carrying out comparative case studies on wood and other sustainable construction solutions, and by combining these contextual analyses with more general views of the organizational changes, for example, by utilizing large dataset analyses of the pioneer companies in the markets. Both in-depth and general perspectives are needed to grasp the systemic changes, to construct alternative scenarios on the evolving PSS, and to assess the implications of these scenarios for the wood-based solutions, wood industries as well as the forest-based sector developments on a broad scale. None of today's PSS models alone capture the future PSS, and that is why alternative scenarios are needed.

DISCUSSION AND CONCLUSIONS

The aim of this research was to contribute to the analysis of changes in the forest-based sector by providing means to organize knowledge on service trends as well as sharpen the analytical focus of the forest-based sector research on this phenomenon. This section concludes the findings obtained using the analytical framework of MLP and discusses the contribution and limitations of this research.

Questions on service trends for the forest-based sector

The empirical studies assessed service trends with three overlapping system definitions and the categorizations derived from service research to detect service trends in each study context separately. As summarized with the MLP analytical framework, these studies are three distinct but complementary perspectives on service trends and change in the forest-based sector, i.e., the structural changes of forest-based value-added chains, system change in the construction regime, and the evolving PSS in the markets. Service trends are observable as part of the changing sociotechnical systems and, as demonstrated in the empirical studies, the gradual changes in the operating environments of the forest-based industries (Table 5).

Key questions for structural changes and the future can be concluded as follows. Firstly, the question of service trends is necessarily also a question about customers and their changing processes. When analyzing service trends of the forest-based sector, it would be important to assess the organizational changes on multiple scales, such as in individual

Table 5 Synthesis: service trends as part of the evolving sociotechnical landscape, and the key questions for structural changes and the future.

	Services as inputs, outputs, and processes/solutions	Service as qualitative process characteristics	System change potential
Gradual changes in the operating environments of the forest-based industries	Add-on and support services; increasing understanding of customer processes; “co-production of solutions”	Adaptation to the customer processes and integration of industrial processes; data as a service, and non-technological innovations; “co-creation of value”	Parallel PSS developed; experimentation; as-a-service platforms, and processes of de/re-configurations
Perspective on the forest-based sector and bioeconomy	Structural changes in the forest-based sector	System change in construction	Evolving markets
Key questions for structural changes and the future	The question of service trends is necessarily a question about the customers/users and their changing processes.	The question of service trends is a question about enabling technologies, role of services, and systemic change.	The question of service trends is a question about change potential, and it extends beyond the present production paradigm.

companies, or for producer-customer dyads, networks, and at higher system levels all in parallel. This helps to understand how the macro(economic) trends, such as servitization or digitalization, translate into observable signals of the changing operating environment. If the analyses on services focus on the support services or the service business opportunities already found in the forest-based sector value-added chains, the radar for a future outlook is limited. A forest industry company may well start assessing their business options by asking the question whether or not to add services to products, and whether or not move downstream—or upstream—of the value-added chains. However, converting the support services into new service businesses, or combining the new bio-based solutions with services to support their adoption by new customers can be expected to affect the business models and the way operations are organized in the forest-based sector.

Secondly, for analyzing service trends as part of increasingly integrated production systems, the question of changing processes extends also to technological change. Parallel to technology-enabled services, the question also concerns services to enable technology. The forest-based sector and its organizations may seek to play an active role in the sociotechnical system changes, for example, by developing support services to improve process efficiency for material substitution, or by rethinking the value-added chains in the construction sector to exploit new business opportunities with digital tools. The outcome of systemic change, however, is not manageable by any single industry or sociotechnical sub-system alone. In service research terms, serving customer processes in a manner that they can support the forest-based sector goals, or support to sustain the forest-based industries' success, is a case of providing knowledge-intensive services. Instead of the knowledge-based services delivering a solution to the customer, here the emphasis is on involving the customer/user resources to make use of the solution provider's resources. Technology is adapted in interactions which are open to new feedback loops, ideas, positive and negative externalities. While this observation allows seeking windows of opportunity to direct the change—for example, to renew the forest-based industries or to develop new nature-based services—the outcome remains open.

Consequently, the third point for consideration: the question of service trends extends beyond today's industrial systems and calls for assessing the impact of alternative scenarios for the forest-based sector. The empirical analyses demonstrated the tensions within service trends. These tensions do not only concern the macro-level developments of digitalization, urbanization, globalization and tertiarization, but also act as signals which are identifiable in company operations and market interactions. Regarding the evolving PSS, a game changing question for the forest-based sector is whether the forest-based sector focuses on serving the PSS of today or whether it will seek to contribute to the next generation of PSS solutions. In this research the question was exemplified in sustainable housing construction as the PSS developed for energy and resource efficiency, urban functionality, and climate change adaptation, as well as green infrastructures, human health, and wellbeing. Such solutions are already developed in the markets.

Services for society, such as the multiple benefits provided by forest ecosystem services, and the social, economic and environmental benefits created by the sustainable management and use of forests, can be understood as one lane of system integration. It is noteworthy that due to the analytical focus of this research on industrial production and sociotechnical system change, forestry and sustainable forest management remain in a relatively invisible role within the analyzed value-added chains. When assessed from the perspective of the industrial supply chains and networks, forestry serves the present forest-based industry value-added chains and their efficiency. The starting point for developing alternative scenarios for forests

or forestry services in the future bioeconomic processes is narrow. However, the benefits produced via sustainable management and the use of natural resources already serve several other 'customers'. Instead of service outlooks or predictions of probable market developments, alternative scenarios are needed as a necessary testing ground for the forest-based industry strategies, for innovative solutions for bioeconomy services, as well as for forest-based processes designed for the future bioeconomy.

Contribution and implications

The analytical framework in this research is based on evolutionary theorizing. MLP was used as device to examine structural changes in the forest-based sector and development of a future bioeconomy. The analysis does not lead to conclude an outlook for the future, but rather, emphasizes systemic understanding on the operating environment. The contribution of the analytical framework is that service trends and the forest-based sector are placed within a broader sociotechnical change including both incremental changes and system discontinuities. The macroeconomic developments of the operating environment, the organizational changes ongoing in the forest-based sector, as well as new models of a future bioeconomy can be assessed within the same analytical device. Changing the perspective from a forest-based sector value-added chain to the industrial production system of construction and, further, to the evolving markets, translates the exogenous trends of manufacturing servitization or automation of services into endogenous developments already ongoing in the forest-based sector value networks.

The empirical studies explicate service trends in concrete examples of services and PSS. Consequently, the questions already assessed on service trends in the forest-based sector research gain more detail. For example, the question on global value chains and trade in tasks (Hetemäki 2011; Näyhä et al. 2015) is defined in the context of industrial construction as a market-based question: regulations and standards related to construction are local, but at the same time, digital infrastructures and data as-a-service operations are ongoing, and potentially changing the construction regime. Additionally, the question of forest industry servitization (Toppinen et al. 2013; Brege et al. 2014) is becoming more divergent: moving downstream is one option for servitization but increasing the integration of industrial processes and the consequent de/re-configurations could enable rethinking the added value. These openings are difficult to capture within the forest-based sector value-added chains. The forest-based sector's search for novel solutions depicts technological trajectories and path dependencies built within the sociotechnical systems.

The empirical analyses in this research demonstrate that increasing efficiency, but also a paradigmatic change potential already resides in the industrial networks and company interaction in several lanes of future developments. From the perspective of the forest-based industries analyzed in the three studies, the responses to service trends can be framed as a move between the value-added chain tasks, an active part playing in the system change of construction, or an assessment of the systemic change ongoing as something beyond one's own decisions, and open to a wider variety of development paths than the dominant production paradigm suggests. For the forest-based sector researchers developing alternative scenarios on forest product markets or the use of forest resources, these perspectives can function as steppingstones for scenario storylines which are new but still credible for practitioners, as well as policy and decision makers.

New bioindustries and related servicing due to biotechnologies and new bioprocesses have already been explored in technology innovation related studies (e.g. Miles et al. 2018; European Commission 2022). The analyses in this research on industrial wood construction and sustainable housing construction showed that new biomaterials, processes and technologies are only emerging in the markets—including the examples of engineered wood for multistory construction, sensors and green infrastructures. New solutions developed by the forest industries, for example, for substituting plastics or different chemical compounds were not exemplified in the analyzed supply networks. Overall, bioeconomy supply chains for new solutions and processes are only forming out. The questions on services and system change potential are timely both for the traditional forest-based value chains, the emerging bioindustries and the future.

Even though this research does not describe the next-generation PSS, the de/re-configurations, dismantling of operations and diversification of market operators provide necessary elements for building plausible alternative scenarios of digital servitization, circular designs, sharing platforms and sustainable bioeconomy solutions. What seems speculative thinking in one industrial context, may already be found in another context to be tested and applied in the markets. The present thesis demonstrates the importance of system boundary definitions in analyzing trends and their impacts for the forest-based sector in a systematic manner. In accordance with systems thinking principles, system boundaries exist for analytical purposes only. A system cannot be found in terms of precise definitions in the real world. In order to support decision makers, researchers need to be clear in communicating their results together with the system definitions used in the analysis, thus, including what is left out of the analysis, and which implication these choices have on the conclusions made.

Limitations

In this research the perspective is deliberately from the outside-in to the forest-based sector change and bioeconomy on multiple levels and scales of organizational change. The approach chosen has its limitations. MLP on sociotechnical transitions was combined with knowledge bases of the service research disciplines, in particular the conceptualizations from operations management and marketing management. The approach was pragmatic and systematized information collection on service trends. The picture that unfolds for service trends in the forest-based sector operating environment is general. Introductions to the heterogenous service research fields remain brief and the key questions on service trends concluded in the end for the forest-based sector are, in principle, applicable to any industrial activity—not specific to the natural resources sectors alone.

Instead of a phenomenon-driven approach and three parallel angles of the empirical investigations, a theory-driven approach could have resulted in more solid grounds for future research. By assessing the ontological and epistemological basis more thoroughly, a suitable service research conceptualization could have been selected to study one service trend with the MLP framework. Such further scrutiny could also have contributed to the theory development of MLP. For example, service innovation research could provide means to tackle the radical vs. incremental innovation divide noted by Geels (2018), or the marketing management discipline on complex business environments (Möller et al. 2020) or on institutionalization in service ecosystems (Vargo et al. 2023) could contribute to the micro-foundations of sociotechnical regimes (Geels 2020). With more thorough theory work,

hypotheses on cause-effect chains could have been made, and a service trend analyzed for its implications, for example, on the likely organizational changes in the forest-based sector. This research did not seek an explanatory model, nor an outlook on services in the forest-based sector. The empirical studies illustrate analyses in breadth, not in depth.

The content analysis methods applied in this research are a fairly simple analytical approach. The contribution of this research is in the contextualization of service trends for the forest-based sector. Instead of the qualitative assessments, the categorizations and conceptual models defined in Articles II and III could also be used for computational data analysis of large datasets. The analysis of large datasets for one service trend specifically would contribute more evidence on the operating environment. Such an analysis, however, cannot be made without the initial qualitative analysis, and validity check of the results attainable from computational methods.

Phenomenon-driven research is bound to its context, time, and space. The three empirical studies can be assessed concerning their scientific scrutiny: are the data, methods, analysis, and the means to the conclusions described transparently—also reflecting the possible weakness of the approaches chosen? Is the analysis replicable in similar contexts and with the data sources of today? From the synthesis perspective, however, a more interesting question would be to test the analytical framework: would a similar synthesis be made if different forest-based sector contexts were chosen, and based on these choices, if different service research knowledge bases were utilized? For example, forest-based tourism was analyzed with the indicators of organizational change derived from research on hospitality services, consultancy services with those from research on knowledge-intensive business services, or digital forest owner services with those from service science. When concluding the three questions for the forest-based sector, did the empirical analyses capture something fundamental about the sociotechnical landscape of the evolving bioeconomy?

For an evaluation of this research and the synthesis made, thus, user assessment is invited from the reader: are the perspectives novel for the forest-based sector and bioeconomy transitions? Furthermore, can the reader translate the examples of services, PSS and the organizational changes presented in this thesis to similar examples from their own operating environment, and possibly, elaborate further examples of likely—or intriguing—future PSS? If the answer is yes, then the pragmatic-empirical approach of this thesis to consider system changes can be deemed as justified.

Future research

The previous sections already indicate several avenues of future research on service trends: empirical analyses to connect in-depth case studies with higher system-level aggregation of the operating environment changes in the forest-based sector; foresight and outlook studies combining qualitative scenario storylines with a quantitative scenario analysis of a future bioeconomy; and more through theoretical groundwork toward explanatory models, or more solid grounds to simulation of alternative sociotechnical developments in order to assess their impact on the forest-based sector.

The analytical focus proposed in this research calls for cross-disciplinary research. Whether the research question was about customers of the forest-based solutions, technology-enabled services, or service innovation, forest-based sector researchers will benefit from closer collaboration with service researchers. Likewise, service researchers studying company operations, and changing markets, will benefit from a broader view on the

social, technological, economic, environmental, and policy developments that have resulted the past trends and affect the future.

Shift between system elements illustrates something we know to detect and describe as a change, such as move from one value-added chain tier to another, from products to services, or from person-to-person services to automated services. A move from one system state to another is more abstract and ambiguous when described ex-ante. Collaboration with practitioners, stakeholders, policy and decision makers is essential in transitions research. For example, bioeconomy services could be a future-oriented question of interest both for the forest researchers and service researchers—not only as a question of biotechnology, but also a question of human-nature interactions in a digital era. The urban forestry research community is already exploring these themes, but the question is relevant also in rural contexts and for traditional forest-based activities. Transitions research frameworks could be used to tackle questions on the sustainable use of forests from a new angle, for example, in services for climate change mitigation and adaptation or biodiversity conservation.

Natural resources sectors are a timely context for analysis on sociotechnical transitions. Technology is not a panacea; breakthrough technologies create new solutions but also new kinds of problems. Analyses of alternative scenarios also require a critical assessment of the PSS and service-based solutions with new digital and algorithmic infrastructures, including ethical considerations of the bioeconomy markets, and de/re-configuration of industrial processes. In pragmatic terms, conceptualizations or models are not the point, but rather the outcome and use of research; how the forest-based sector research is able to contribute to forest professionals and practitioners, the forest-based industries and organizations orientating in an uncertain world.

REFERENCES

Ali-Yrkkö J (2013) Mysteeri avautuu, Suomi globaaleissa arvoverkostoissa (in Finnish). ETLA B:257. Taloustieto Oy, Helsinki.

Ali-Yrkkö J, Rouvinen P (2015) Slicing up global value chains: a micro view. J Ind Compet Trade 15: 69–85. https://doi.org/10.1007/s10842-014-0192-2

Anderson F (2006) A comparison of innovation in two Canadian forest service support industries. For Policy Econ 8(7): 674–682. https://doi.org/10.1016/j.forpol.2005.06.015

Andersson E, Keskitalo ECH (2019) Service logics and strategies of Swedish forestry in the structural shifts of forest ownership: challenging the "old" and shaping the "new". Scand J For Res 34(6): 508–520. http://dx.doi.org/10.1080/02827581.2019.1604990

Arthur WB (1988) Competing technologies: an overview. In: Dosi G, Freeman C, Nelson R, Silverberg G, Soete L (Eds.) Technical Change and Economic Theory. Pinter, London, pp. 590–607.

Baines TS, Lightfoot HW, Evans S, Neely A, Greenough R, Peppard J, Roy R, Shehab E, Braganza A, Tiwari A, Alcock J, Angus J, Bastl M, Cousens A, Irving P, Johnson M, Kingston J, Lockett H, Martinez V, Michele P, Tranfield D, Walton IM, Wilson H (2007) State-of-the-art in product-service systems. P I Mech Eng B-J Eng 221(10): 1543–1552. https://doi.org/10.1243/09544054JEM858

Berghäll S (2018) Service Marketing Phenomena in the Context of Private Forest Owners—a Service Dominant Logic Perspective on Scholarly Literature. Curr Forestry Rep 4: 125–137. https://doi.org/10.1007/s40725-018-0081-8

Boehm M, Thomas O (2013) Looking beyond the rim of one's teacup: a multidisciplinary literature review of Product-Service Systems in Information Systems, Business Management, and Engineering & Design. J Clean Prod 51: 245–260. https://doi.org/10.1016/j.jclepro.2017.11.083.

Brege S, Stehn L, Nord T (2014) Business models in industrialized building of multi-storey houses. Constr Manag Econ 32: 208–226. https://doi.org/10.1080/01446193.2013.840734

Breidbach C, Choi S, Ellway B, Keating BW, Kormusheva K, Kowalkowski C, Chiehyeon L, Maglio P (2018) Operations without operation: how is technology changing the role of the firm? J Serv Manag 29(5): 809–833. https://doi.org/10.1108/JOSM-05-2018-0127

Carlborg P, Kindström D, Kowalkowski C (2014) The evolution of service innovation research: a critical review and synthesis. Serv Ind J 34: 373–398. https://doi.org/10.1080/02642069.2013.780044

Chang Y-C, Miles I, Hung S-H (2014) Introduction to special issue: Managing technology-service convergence in Service Economy 3.0. Technovation 34: 499–504. https://doi.org/10.1016/j.technovation.2014.05.011

Clark P (2005) The rise of the service provider. New Zeal J For 9–12.

Coombs R, Miles I (2000) Innovation, measurement and services: the new problematique. Chapter 5 in innovation systems in the service economy. Eco Sci Tech Innovation 18: 85–103. https://doi.org/10.1007/978-1-4615-4425-8_5

Cusumano MA, Kahl SJ, Suarez FF (2015) Services, industry evolution, and the competitive strategies of product firms. Strateg Manag J 36(4): 559–575. https://doi.org/10.1002/smj.2235

Dasgupta P (2021) The Economics of Biodiversity: The Dasgupta Review. London: HM Treasury.

Davidsson N, Edvardsson B, Gustafsson A, Witell L (2009) Degree of service-orientation in the pulp and paper industry. Int J Services Techn Manag 11: 24–41. https://doi.org/10.1504/IJSTM.2009.022380

De Backer K, Desnoyers-James I, Moussiegt L (2015) Manufacturing or Services – That is (not) the Question: The Role of Manufacturing and Services in OECD Economies. OECD Science, Technology and Industry Policy Papers, No. 19, OECD Publishing, Paris. http://dx.doi.org/10.1787/5js64ks09dmn-en

DiMaggio P, Powell W (1983) The iron cage revisited: institutional isomorphism and collective rationality in organizational fields. Am Sociol Rev 48: 147–160. https://doi.org/10.2307/2095101

Dosi G (1982) Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. Res Policy 6(3): 147–162. https://doi.org/10.1016/0048-7333(82)90016-6

Efken J, Dirksmeyer W, Kreins P, Knechtd M (2016) Measuring the importance of the bioeconomy in Germany: Concept and illustration. NJAS – Wageningen Journal of Life Sciences 77: 9–17. https://doi.org/10.1016/j.njas.2016.03.008

Elzen B, Geels FW, Green K Eds. (2004) System Innovation and the Transition to Sustainability – Theory, Evidence and Policy. Edward Elgar Publishing, Cheltenham

European Commission (2014) High Level Group on Business Services Final report, April 2014, European Union, 2014.

European Commission (2022) European bioeconomy policy: stocktaking and future developments. Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Publications Office of the European Union, 2022. https://data.europa.eu/doi/10.2777/997651

Eurostat (2008) NACE Rev. 2. Statistical classification of economic activities in the European Community. Eurostat Methodologies and Working Papers, European Commission, Luxembourg.

Fisk RP, Grove SJ (2010) The Evolution and Future of Service – Building and Broadening a Multidisciplinary Field. Handb Serv Sci: 643–663. https://doi.org/10.1007/978-1-4419-1628-0_28

Freeman C, Loucã F (2001) As Time Goes By: From the Industrial Revolutions to the Information Revolution. Oxford University Press, Oxford. https://doi.org/10.1093/0199251053.001.0001

Gallouj F, Savona M (2009) Innovation in services: a review of the debate and a research agenda. J Evol Econ 19: 149–172. https://doi.org/10.1007/s00191-008-0126-4

Gallouj F, Weinstein O (1997) Innovation in services. Res Policy 26: 537–556. https://doi.org/10.1016/S0048-7333(97)00030-9

Gallouj W, Windrum P (2009) Services and Services Innovation. J Evol Econ. 19: 141–148. https://doi.org/10.1007/s00191-008-0123-7

Geels FW (2002) Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. Res Policy 31: 1257–1274 https://doi.org/10.1016/S0048-7333(02)00062-8

Geels FW (2004) From sectoral systems of innovation to socio-technical systems: insights about dynamics and change from sociology and institutional theory. Res Policy33: 897–920. https://doi.org/10.1016/j.respol.2004.01.015

Geels FW (2005) Processes and patterns in transitions and system innovations: Refining the co-evolutionary multi-level perspective. Technol Forecast Soc 72: 681–696. https://doi.org/10.1016/j.techfore.2004.08.014

Geels FW (2010) Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. Res Policy 39: 495–510. https://doi.org/10.1016/j.respol.2010.01.022

Geels FW (2011) The multi-level perspective on sustainability transitions: responses to seven criticisms. Environ Innov Social Transit 1: 24–40. https://doi.org/10.1016/j.eist.2011.02.002

Geels FW (2018) Disruption and low-carbon system transformation: progress and new challenges in socio-technical transitions research and the Multi-Level Perspective. Energy Res Soc Sci 37: 224–231. https://doi.org/10.1016/j.erss.2017.10.010

Geels FW (2020) Micro-foundations of the multi-level perspective on socio-technical transitions: Developing a multi-dimensional model of agency through crossovers between social constructivism, evolutionary economics and neoinstitutional theory. Technol Forecast Soc 152: 119894. https://doi.org/10.1016/j.techfore.2019.119894

Geels FW, Schot J (2007) Typology of sociotechnical transition pathways. Res Policy 36: 399–417. https://doi.org/10.1016/j.respol.2007.01.003

Gokhberg L, Fursov K, Miles I, Perani G (2013) Developing and using indicators of emerging and enabling technologies. In: Handbook of Innovation Indicators and Measurement. Edward Elgar Publishing. Pp 349–380.

Grin J, Rotmans J, Schot J, (collaboration with) Geels FW, Loorbach D, eds. (2010) Transitions to Sustainable Development: New Directions in the Study of Long Term Transformative Change. New York: Routledge. https://doi.org/10.4324/9780203856598

Grönroos C (2006) Adopting a service logic for marketing. Mark Theory 6: 317–333. https://doi.org/10.1177/1470593106066794

Gummesson E, Grönroos C (2012). The emergence of the new service marketing: Nordic School perspectives. J Serv Manag 23(4): 479–497 https://doi.org/10.1108/09564231211260387

Hansen E (2016) Responding to the Bioeconomy: Business Model Innovation in the Forest Sector. In Environmental Impacts of Traditional and Innovative Forest-based Bioproducts, eds. Kutnar A, Muthu SS. Singapore: Springer. Pp 227–248. https://doi.org/10.1007/978-981-10-0655-5_7

Herpin-Saunier N, Jarvis I, van den Bosch M (2018) Human Health: A Tertiary Product of Forests. in Farcy, C., Martinez de Arano, I. and Rojas-Briales E. (eds) Forestry in the Midst of Global Changes. CRC Press, Taylor & Francis: Boca Ratton. Pp 215–253.

den Hertog P, Rubalcaba L (2010) Policy frameworks for service innovation. A menu-approach. In: Gadrey J, Gallouj J, editors. Handbook of innovation and services. Edward Elgar Publishing Ltd, Cheltenham. Pp. 621–652. https://doi.org/10.4337/9781849803304.00040

Hetemäki L (2011) Metsäalan palveluvaltaistuminen. In: Hetemäki L, Niinistö S, Seppälä R, Uusivuori J (Eds) Murroksen jälkeen – Metsien käytön tulevaisuus Suomessa, METLA, Metsämiestensäätiö, Metsäkustannus Oy. Pp. 70–76.

Hetemäki L (ed) (2014) Future of the European forest-based sector: Structural changes towards bioeconomy. What Science Can Tell Us 6. European Forest Institute. https://efi.int/sites/default/files/files/publication-bank/2018/efi_wsctu6_2014.pdf

Hetemäki L, Hänninen R (2013) Suomen metsäalan taloudellinen merkitys nyt ja tulevaisuudessa. Kansantaloudellinen aikakauskirja [The Finnish Economic Journal] 2: 191–208.

Hetemäki L, Hanewinkel M, Muys B, Ollikainen M, Palahí M, Trasobares A (2017) Leading the way to a European circular bioeconomy strategy. From Science to Policy 5. European Forest Institute. http://www.efi.int/files/attachments/publications/efi_fstp_5_2017.pdf

Holopainen J (2016) Changing institutions and consumer-driven development of forest products and services. Dissertationes Forestales 223. 69 p. http://dx.doi.org/10.14214/df.223

Holopainen J, Mattila O, Pöyry E, Parvinen P (2020) Applying design science research methodology in the development of virtual reality forest management services. For Policy Econ 116: 102190. https://doi.org/10.1016/j.forpol.2020.102190

Hsieh H-F, Shannon S (2005) Three Approaches to Qualitative Content Analysis. Qual Health Res 15(9): 1277–1288. http://dx.doi.org/ 10.1177/1049732305276687

Hujala T, Pykäläinen J, Tikkanen J (2007) Decision making among Finnish non-industrial private forest owners: The role of professional opinion and desire to learn. Scand J For Res 22(5): 454–463. https://doi.org/10.1080/02827580701395434

Hujala T, Toppinen A, Butler BJ (2019) Services in Family Forestry. Springer. World Forests (WFSE, volume 24). Springer Nature Switzerland AG 2019. https://doi.org/10.1007/978-3-030-28999-7

Hull RB, Nelson K (2011) Wildland–urban interface forest entrepreneurs: a look at a new trend. J For 109(3): 136–140. https://doi.org/10.1093/jof/109.3.136

Hurmekoski E, Hetemäki L (2013) Studying the future of the forest sector: review and implications for long-term outlook studies. For Policy Econ 34: 17–29. https://doi.org/10.1016/j.forpol.2013.05.005

Hurmekoski E, Jonsson R, Korhonen J, Jänis J, Mäkinen M, Leskinen P, Hetemäki L (2018) Diversification of the forest industries: role of new wood-based products. Can J For Res 48: 1417–1432 http://dx.doi.org/10.1139/cjfr-2018-0116

Hurmekoski E, Lovrić M, Lovrić N, Hetemäki L, Winkel K (2019) Frontiers of the forest-based bioeconomy – A European Delphi study. For Policy Econ 102: 86–99 https://doi.org/10.1016/j.forpol.2019.03.008

King N, Brooks J (2019) Thematic Analysis in Organisational Research. In: Cassell C (ed) The SAGE Handbook of Qualitative Business and Management Research Methods: Methods and Challenges. SAGE Publications Ltd. London. http://dx.doi.org/10.4135/9781526430236 pp. 219-236

Kivimaa P, Boon W, Hyysalo S, Klerkx L (2019) Towards a typology of intermediaries in sustainability transitions: A systematic review and a research agenda, Res Policy 48(4): 1062–1075. https://doi.org/10.1016/j.respol.2018.10.006

Korhonen J, Koskivaara A, Toppinen A (2020) Riding a Trojan horse? Future pathways of the fiber-based packaging industry in the bioeconomy. For Policy Econ 110: 101799. https://doi.org/10.1016/j.forpol.2018.08.010

Kowalkowski C, Gebauer H, Oliva R (2017) Service growth in product firms:past, present, and future. Ind Market Manage 60: 82–88. https://doi.org/10.1016/j.indmarman.2016.10.015

Krippendorff K (2019) Content analysis: an introduction to its methodology. SAGE Publications, Inc. 2019, 4th edition. https://dx.doi.org/10.4135/9781071878781

Kunttu J, Hurmekoski E, Heräjärvi H, Hujala T, Leskinen P (2020) Preferable utilisation patterns of wood product industries' by-products in Finland. For Policy Econ 110: 101946. https://doi.org/10.1016/j.forpol.2019.101946

Kuosmanen T, Kuosmanen N, El Melig A, Ronzon T, Gurria Albusac P, Iost S, M`barek, R (2020) How big is the bioeconomy, EUR 30167 EN, Publications Office of the European Union, Luxembourg. http://dx.doi.org/10.2760/144526

Kuusisto, J. (Ed.) (2006) Knowledge-intensive Service Activities in the Finnish Forest and Related Engineering and Electronics Industries (Forenel). Cluster OECD.

Laakkonen A, Hujala T, Pykäläinen J (2018) Integrating intangible resources enables creating new types of forest services - developing forest leasing value network in Finland. For Policy Econ 99: 157–168. https://doi.org/10.1016/j.forpol.2018.07.003

Lähtinen K, Häyrinen L. (2022) Servitisation and the future of business development – insights from the forest industry. In: D'Amato D, Toppinen A, Kozak R Eds. The Role of Business in Global Sustainability Transformations. London, Routledge pp. 96-115. https://doi.org/10.4324/9781003003588-9

Lähtinen K, Toppinen A (2008) Financial performance in Finnish large and medium-sized sawmills: The effects of value-added creation and cost-efficiency seeking. J For Econ 14: 289–305. https://doi.org/10.1016/j.jfe.2008.02.001

van Lente H, Hekkert M, Smits, R, van Waveren, B (2003) Roles of Systemic Intermediaries in Transition Processes. Int J Innov Manag 7(3): 247–279. https://doi.org/10.1142/S1363919603000817

Loorbach D, Frantzeskaki N, Avelino F (2017) Sustainability transitions research: transforming science and practice for societal change. Annu Rev Environ Resour 42(1): 599–626. https://doi.org/10.1146/annurev-environ-102014-021340

Luoma P, Penttinen E, Tapio P, Toppinen A (2022) Future images of data in circular economy for textiles. Technol Forecast Soc 182: 121859. https://doi.org/10.1016/j.techfore.2022.121859

Makkonen M (2018) Stakeholder perspectives on the business potential of digitalization in the wood products industry. BioProducts Bus 3(6): 63–80. https://doi.org/10.22382/bpb-2018-006

Makkonen M (2019) Renewing the sawmill industry: studies on innovation, customer value and digitalization Dissertations Forestales 269. https://doi.org/10.14214/df.269

Malaska P (1999) Conceptual framework for the autopoietic transformation of societies. Turku: University of Turku. http://www.utu.fi/fi/yksikot/ffrc/tutkimus/hankearkisto/Documents/futu_5_99.pdf

Markard J, Raven R, Truffer B (2012) Sustainability transitions: an emerging field of research and its prospects. Res Policy 41: 955–967. https://doi.org/10.1016/j.respol.2012.02.013

Maroto A, Rubalcaba, L (2008) Services productivity revisited. Serv Ind J 28(3): 337–353. https://doi.org/10.1080/02642060701856209

Matthies BD, D'amato D, Berghäll SA, Ekholm T, Hoen FF, Holopainen JM, Korhonen JE, Lähtinen KP, Mattila OPA, Toppinen AMK, Valsta LT, Wang L, Yousefpour, R (2016) An Ecosystem Service-Dominant Logic? – Integrating the ecosystem service approach and the service-dominant logic. J Clean Prod 124: 51–64. https://doi.org/10.1016/j.jclepro.2016.02.109

Mattila O (2015) Towards service-dominant thinking in the Finnish forestry service market. Dissertationes Forestales 198. 61 p. http://dx.doi.org/10.14214/df.19

Mattila O, Roos A (2014) Service logics of providers in the forestry servicessector: evidence from Finland and Sweden. For Policy Econ 43: 10–17. https://doi.org/10.1016/j.forpol.2014.03.003

Miles I (2016) Twenty years of service innovation research. In: Toivonen, M. (Ed.), Service Innovation: Novel Ways of Creating Value in Actor Systems. Springer Japan, Tokyo, pp. 3–34. https://doi.org/10.1007/978-4-431-54922-2_1

Miles ID, Belousova V, Chichkanov N (2018). Knowledge intensive business services: ambiguities and continuities. Foresight 20(1): 1–26. https://doi.org/10.1108/FS-10-2017-0058

Miroudot S, Cadestin C (2017) Services In Global Value Chains: From Inputs to Value-Creating Activities. OECD Trade Policy Papers, No. 197, OECD Publishing, Paris. http://dx.doi.org/10.1787/465f0d8b-en

Möller K, Nenonen S, Storbacka K (2020) Networks, ecosystems, fields, market systems? Making sense of the business environment. Ind Market Manage 90: 380–399. https://doi.org/10.1016/j.indmarman.2020.07.013

Mont O (2002) Clarifying the concept of product-service system. J Clean Prod 10(3): 237–245. https://doi.org/10.1016/S0959-6526(01)00039-7

Morgan DL (2013) Integrating qualitative and quantitative methods: A pragmatic approach. Thousand Oaks, CA: SAGE. https://dx.doi.org/10.4135/9781544304533

Muench S, Stoermer, E Jensen K, Asikainen T, Salvi M, Scapolo F (2022) Towards a green and digital future, EUR 31075 EN, Publications Office of the European Union, Luxembourg, 2022. http://dx.doi.org/10.2760/977331

Murcia MJ, Siegner M, Deboer J (2018) Main Findings and Trends of Tertiarization. in Farcy C, Martinez de Arano I, Rojas-Briales E (eds) Forestry in the Midst of Global Changes. CRC Press, Taylor & Francis: Boca Ratton. Pp. 185–194. https://doi.org/10.1201/b21912-11

Näyhä A (2020) Finnish forest-based companies in transition to the circular bioeconomy - drivers, organizational resources and innovations. For Policy Econ 110: 101936. https://doi.org/10.1016/j.forpol.2019.05.022

Näyhä A, Pelli P, Hetemäki L (2015) Services in the forest-based sector−unexplored futures. Foresight 17: 378–398. http://dx.doi.org/10.1108/FS-08-2013-0034

Neely A (2008) Exploring the financial consequences of the servitization of manufacturing. Oper Manage Res 1(2): 103–118. https://doi.org/10.1007/s12063-009-0015-5

Nelson RR, Winter SG (1982) An evolutionary theory of economic change. Boston, MA: Belknap.

Niskanen A, Donner-Amnell J, Häyrynen S, Peltola T (2008) Metsän uusi aika: kohti monipuolisempaa metsäalan elinkeinorakennetta. University of Joensuu, Faculty of Forestry.

Niskanen A, Slee B, Ollonqvist P, Pettenella D, Bouriaud L, Rametsteiner E (2007) Entrepreneurship in the forest sector in Europe. Faculty of Forestry, University of Joensuu. Silva Carelica 52.

Normann, R (2001) Reframing Business: When the Map Changes the Landscape. John Wiley & Sons Ltd, Chichester.

OECD (2006) Knowledge intensive service activities. OECD, Paris. 179 p. https://doi.org/10.1787/9789264022744-en

OECD (2017) The Next Production Revolution. Implications for Governments and Business. OECD Publishing, Paris. https://doi.org/10.1787/9789264271036-en

Parasuraman A, Zeithaml VA, Berry LL (1985) A conceptual model of service quality and its implications for future research. J Market 49(4): 41–50. https://doi.org/10.1177/002224298504900403

Payne A, Frow P, Eggert A (2017) The customer value proposition: evolution, development, and application in marketing. J Acad Market Sci 45: 467–489. https://doi.org/10.1007/s11747-017-0523-z

Pelli P, Kangas J, Pykäläinen J (2018) Service-Based Bioeconomy - Multilevel Perspective to Assess the Evolving Bioeconomy with a Service Lens. In Towards a Sustainable Bioeconomy: Principles, Challenges and Perspectives, eds. Leal Filho, W., Pociovălișteanu, D., Borges de Brito, P. and I. Borges de Lima. World Sustainability Series. Cham: Springer. Pp. 17–42. https://doi.org/10.1007/978-3-319-73028-8_2

Pynnönen S, Haltia E, Hujala T (2021) Digital forest information platform as service innovation: Finnish Metsaan.fi service use, users and utilization. For Policy Econ 125: 102404. https://doi.org/10.1016/j.forpol.2021.102404

Rabetino R, Harmsen W, Kohtamäki M, Sihvonen J (2018) Structuring servitization-related research. Int J Oper Prod Manag 38(2): 350–371. https://doi.org/10.1108/IJOPM-03-2017-0175

Räty T, Toppinen A, Roos A, Riala M, Nyrud AQ (2016) Environmental policy in the Nordic wood product industry: insights into firms' strategies and communication. Bus Strategy Environ 25: 10–27. https://doi.org/10.1002/bse.1853

Rip A, Kemp R (1998) Technological change. In: Rayner, S. & Malone, E. L. (toim.) Human choice and climate change. Battelle Press, Columbus, Ohio. Pp 327–399.

Rönnlund I, Pursula T, Bröckl M, Hakala L, Luoma P, Aho M, Pathan A, Pallesen BE (2014) Creating Value from Bioresources – Innovation in Nordic Bioeconomy. Nordic Innovation Report 2014:01, May 2014. Gaia Consulting, Agrotech Ltd.

Rotmans J, Kemp R, van Asselt M (2001) More evolution than revolution. Transition management in public policy. Foresight 3: 15–31. https://doi.org/10.1108/14636680110803003

Rotmans J, Loorbach D (2010) Towards a Better Understanding of Transitions and Their Governance: A Systemic and Reflexive Approach. Part II (pp. 105–221) in Grin J, Rotmans J, Schot J, (collaboration with) Geels FW, Loorbach D, eds. 2010. Transitions to Sustainable Development: New Directions in the Study of Long Term Transformative Change. New York: Routledge.

Sáez S, Taglioni D, van der Marel E, Zavacka V (2014) Valuing services in trade: A toolkit for competitiveness diagnostics. Washington, DC: The World Bank. http://hdl.handle.net/10986/21285

Schot J, Geels FW (2007) Niches in evolutionary theories of technical change. A critical survey of the literature. J EvolEcon 17: 605–622. https://doi.org/10.1007/s00191-007-0057-5

Schumpeter JA (1939) Business cycles: a theoretical. Historical and Statistical Analysis of the Capitalist Process. McGraw-Hill, New York.

Schwarz GM, Stensaker IG (2016) Showcasing phenomenondriven research on organizational change, J Chang Manag 16(4): 245–264. http://dx.doi.org/10.1080/14697017.2016.1230931

Scott WR (1995) Institutions and organizations. Sage Publications, London/New Delhi.

Scott WR (2014) Institutions and organizations: ideas, interests, and identities. Thousand Oaks, CA : SAGE Publications. 4th ed. xiii, 344 p.

Spohrer J, Maglio PP (2008) The Emergence of Service Science: Toward Systematic Service Innovations to Accelerate Co-Creation of Value. Production and Operations Management. 17(3): 238–246. https://doi.org/10.3401/poms.1080.0027

Sundbo J (1997) Management of Innovation in Services. Serv Ind J 17(3): 432–455. http://dx.doi.org/10.1080/02642069700000028

Toivonen M, Tuominen T (2009) Emergence of innovations in services. Serv Ind J 29(7): 887–902. https://doi.org/10.1080/02642060902749492

Toivonen R, Hansen E, Järvinen E, Enroth R-R (2005) The competitive position of the Nordic wood industry in Germany: intangible quality dimensions. Silva Fennica 39: 277–287. https://doi.org/10.14214/sf.389

Toppinen A, Wan M, Lähtinen K (2013) Strategic orientations in the global forest sector. In: Hansen E, Panwar R, Vlosky R. (Eds.), The Global Forest Sector: Changes, Practices, and Prospects. CRC Press, Taylor and Francis Group, Boca Raton, pp. 405–428. http://dx.doi.org/10.1201/b16186-22

Tukker A (2004) Eight types of product-service system: eight ways to sustainability? Experiences from SusProNet. Bus Strateg Env 13(4): 246–260. https://doi.org/10.1002/bse.414

Tukker A (2015) Product services for a resource-efficient and circular economy – a review. J Clean Prod 97: 76–91. https://doi.org/10.1016/j.jclepro.2013.11.049

Tushman M, Anderson P (1986) Technological discontinuities and organization environments. Adm Sci Q 31: 465–493. https://doi.org/10.2307/2392832

Vandermerwe S, Rada J (1988) Servitization of business: adding value by adding services. Eur Manage J 6: 314–324 https://doi.org/10.1016/0263-2373(88)90033-3

Vargo SL, Lusch RF (2004) Evolving into a New Dominant Logic for Marketing. J Mark 68(1): 1–17. https://doi.org/10.1509/jmkg.68.1.1.24036

Vargo SL, Peters L, Kjellberg H, Koskela-Huotari K, Nenonen S, Polese F, Sarno D, Vaughan C. (2023) Emergence in marketing: an institutional and ecosystem framework. J of the Acad Mark Sci 51: 2–22. https://doi.org/10.1007/s11747-022-00849-8

Viitamo E (2013) Servitization as a productive strategy of a firm: evidence from the forest-based industries. ETLA Reports 14. The Research Institute of the Finnish Economy.

Visnjic I, Neely A, Jovanovic M (2018) The path to outcome delivery: interplay of service market strategy and open business models. Technovation 72–73: 46–59. https://doi.org/10.1016/j.technovation.2018.02.003

Wang L, Toppinen A, Juslin H (2015) Use of wood in green building: A study of expert perspectives from the UK. J Clean Prod 65: 350–361. https://doi.org/10.1016/j.jclepro.2013.08.023

Weiss G, Emery MR, Miina J, Kurttila M, Corradini G,Huber P, Vacik H (2019) Value Creation and Innovation with Non-wood Forest Products in a Family Forestry Context. in Hujala et al. (eds) Services in Faminly Forestry, pp. 185–224. http://dx.doi.org/10.1007/978-3-030-28999-7_10

Weiss G, Pettenella D, Ollonqvist P, Slee B Eds. (2011) Innovation in Forestry: Territorial and Value Chain Relationships. CAB International. https://doi.org/10.1079/9781845936891.0000

Wilenius M (2021) Bioeconomy as a Driver for the Upcoming Seventh K-Wave (2050–2100). pp 3–24 In: Koukios, E., Sacio-Szymańska, A. (eds) Bio#Futures. Springer, Cham. https://doi.org/10.1007/978-3-030-64969-2_1

Wolf SA, Primmer E (2006) Between Incentives and Action: A Pilot Study of Biodiversity Conservation Competencies for Multifunctional Forest Management in Finland. Soc Nat Resour 19(9): 845–861. https://doi.org/10.1080/08941920600835601

Wölfl A (2005) The Service Economy in OECD Countries. OECD/Centre d'études prospectives et d'informations internationales (CEPII), OECD Science, Technology and Industry Working Papers, 2005/03, OECD Publishing. https://dx.doi.org/10.1787/212257000720

Zeithaml V, Parasuraman A, Berry L (1985) Problems and strategies in services marketing. J Mark 49: 33–46. https://dx.doi.org/10.2307/1251563

Zott C, Amit R (2010) Business model design: an activity system perspective. Long Range Plan 43: 216–226. https://doi.org/10.1016/j.lrp.2009.07.004.

Zysman J (2006) The 4th Service Transformation: The Algorithmic Revolution. Communications of the ACM 49(7): 48. http://dx.doi.org/10.1145/1139922.1139947