LAPPEENRANTA UNIVERSITY OF TECHNOLOGY
School of Energy Systems
Department of Environmental Technology
Sustainability Science and Solutions
Master's thesis 2018

Taneli Fabritius

ROLE OF SOCIAL INNOVATIONS IN THE SUSTAINABLE TRANSITION – CASE STUDY ON THE VALUE CHAINS OF WOOD CONSTRUCTION AND PACKAGING BOARD

Examiners: Associate professor, Dr. Mirja Mikkilä
Professor, Dr. Lassi Linnanen

(Instructor(s): Associate professor, Dr. Mirja Mikkilä)

TIIVISTELMÄ

Lappeenrannan teknillinen yliopisto
LUT School of Energy Systems
Ympäristötekniikan koulutusohjelma
Sustainability Science and Solutions

Taneli Fabritius

Role of social innovations in the sustainable transition – case forest-based bioeconomy and bioenergy

Diplomityö

14.11.2018

68 sivua, 10 kuvaaja ja 9 taulukkoa.

Työn tarkastaja: Professori, Dr. Lassi Linnanen

Työn ohjaaja: Professori, Dr. Mirja Mikkilä

Hakusanat: diplomityö
Keywords: Master's thesis, bioeconomy, sustainable transition, forest-based bioeconomy, social innovation

Diplomityö käsittelee metsäbiotaloudessa tapahtunutta kestävyysmuutosta ja sosiaalisten innovaatioiden roolia tässä muutoksessa. Aiemmat tutkimukset ovat keskittyneet ympäristökysymyksiin ja taloudellisiin hyötyihin, mutta sosiaalisen kestävyyden näkökulmaa ei ole juuri käsitelty.

Työssä selvitetään sosiaalisten innovaatioiden roolin tarkastelemiseen tarvittava viitekehys, tutkitaan minkälaisia kehityspolkuja valitut arvoketjut ovat kulkeneet viimeisen 20 vuoden aikana, sekä selvitetään minkälaisia ajureita näiden muutosten takana on.

Työn empiirinen osa keskittyy innovaatiotrendeihin puurakentamisen, sekä paperi- ja kartonkipakkausten arvoketjuissa.

ABSTRACT

Lappeenranta University of Technology
LUT School of Energy Systems
Degree Programme in Environmental Technology
Sustainability Science and Solutions

Taneli Fabritius

Role of social innovations in the sustainable transition – case forest-based bioeconomy and bioenergy

Master's thesis

14.11.2018

68 pages, 10 s and 9 tables

Examiner: Professor, Dr. Lassi Linnanen
Supervisor: Associate professor, Dr. Mirja Mikkilä

Keywords: Master's thesis, bioeconomy, sustainable transition, forest-based bioeconomy, social innovation

The role of social innovations in the sustainable transition taken place in Finnish forest based bioeconomy is in the focus of this thesis. Earlier studies have been focused in the environmental and economic dimensions, but little work has been done in understanding possibilities of social sustainability and social innovation in the Finnish forest bioeconomy context.

The necessary framework for investigating the role of social innovations is presented in the thesis. The work also includes research on the development paths which the selected value chains have taken during the past 20 years. In addition, the drivers behind these development paths are investigated.

The empirical part of the work is focused in the innovation trends of wood construction and packaging board value chains.

ACKNOWLEDGEMENTS

Thank you for Associate Professor Mirja Mikkilä for giving me the opportunity to work with this topic and for all the patient instructions during the process. Thank you also LUT for the Master's program and to everyone who has been involved in preparing and teaching the courses, I enjoyed the high quality education in Lappeenranta. I want to thank all the fellow students for interesting discussions during the studies, this was great time. Finally, a huge thank you to everyone who knows that you deserve it, all my achievements are dedicated to you. I look forward to future challenges and believe that this program has given me a good foundation for continuing the work.

"Learning is not a process which has beginning and end."
-unknow

In Lappeenranta 14 December 2018

Taneli Fabritius

TABLE OF CONTENTS

LIST OF SYMBOLS

Abbreviations

LUT Lappeenranta University of Technology

MLP Multi-level perspective

TEF Triple Embeddedness framework

1 INTRODUCTION

The subject for this thesis arises from the need to better understand the role of social innovations in bioeconomy. Increasing demand for depleting resources, climate change, growing global population and changes in consumer behavior are some of the identified drivers for shifting away from fossil economy (TEM 2014). Bioeconomy supports this sustainable transition, as it is associated with potential benefits such as decreased use of fossil resources, reduced carbon dioxide emissions, as well as improved food security and wiser management of natural resources (McCormick & Kautto 2013). Bioeconomy is an economy, where a combination of various existing sectors utilizes renewable bio-based raw-materials for providing food, energy, chemicals, products and services (TEM 2014).

Technological innovation has traditionally allowed development in industries, but current new development paths struggle with finding legitimacy among wider stakeholder groups. In addition, competition and co-operation in the business environment are changing, and overall, sectoral boundaries are being blurred. It has been suggested that a combination of social innovation and technological innovation in the sectoral boundaries could be useful in creating synergies to the socio-technical transition. In this thesis, frameworks for investigating social innovation in bioeconomy are presented. The frameworks are used in a case study for two different value chains for estimating drivers behind Finnish bioeconomy and for creating understanding on what is the role of social innovations in the Finnish bioeconomy. (Mikkilä et al. 2017).

In Finland, bioeconomy is seen also as an opportunity for competitive advantage, and Finland aims to ceate 100 000 new jobs in bioeonomy by 2025 (TEM 2014). However, Bosman and Rotmans (2016) identified that in Finland focus is in incremental innovation, which maintains current industrial structure, rather than radical innovations and they criticized Finland for, for example, traditional top-down governance, unclear problem definition and lack of assessment of the potential resistance and barriers. In addition, Bosman and Rotmans (2016) identified several barriers of bioeconomy, such as lack of sense of urgency, lack of ownership, silo structure and Finnish modesty. Since the current focus in

bioeconomy solutions in environmental and economic dimensions have not reached wide legitimacy, this thesis focuses in the less studied social dimension. (Mikkilä et al. 2017).

Wood is not in the focus of the European union strategy for bioeconomy, but plays a central role in the Finnish bioeconomy (Koistinen 2015, p. 16). Due to the strong role of forest sector in the Finnish bioeconomy, this thesis focuses on studying value chains from the forest-based bioeconomy. Namely these value chains are wood construction and packaging board. Both value chains play an important part in the Finnish bioeconomy and have potential for supporting sustainable development globally. Construction consumes half of worlds natural resources and it generates 40 per cent of waste generated globally (Luke 2017). Wood has the benefit of being only available renewable based material in construction (Forest industries 2017, Luke 2017). Wood construction also stores carbon dioxide for long time and estimates say that wood construction has the potential to save 14 to 31 percent of global CO_2 emissions (Oliver 2014). Fibre based materials account for approximately 31 per cent of the value for the global packaging market (Stora Enso, 2014). Pulp and paper industry takes over half of the total raw wood used in Finland and approximately 1,8 million tons of packaging materials are used annually (Luke 2018, YM 2018).

The European Commission considers that there is a huge potential for social innovation in the bioeconomy (EC 2012, 1.2.7). In addition, the European Commission has underlined different grand societal challenges that require attention (EC 2018). The European Parliament states also that the synthesis between the economy, the environment and social quality could play a positive role in the European growth process (2016/C 075/06, c. 52). However, these ideas are not present in the Finnish strategy for bioeconomy (TEM 2014, p.14). The Finnish bioeconomy strategy mentions social dimension in the context of social sustainability of commercial forests, which is said to be ensured by legislation. Therefore, the European union seems to identify the importance of social innovations in the context of bioeconomy, but Finland doesn't. It is not clear why Finland is operating with different assumptions compared to the EU and therefore, it is necessary to investigate the matter further.

2 RESEARCH DESIGN

In a qualitative study, the interpretations are made along the work, which may complicate explaining the research process in a step-wise manner (Eskola & Suoranta 1998). However, the selection of the materials to be collected for research, the methods for analysing the data and the theoretical framework to be used are interconnected (Alasuutari 2011).

2.1 Objectives and research questions

The main objective of this thesis is to understand better the role of social innovations in the sustainable transition. This thesis objectives are achieved by providing a theoretical framework suitable for understanding the sustainable transition, examining the innovation paths which the selected value chains have followed, and based on the found evidence, discussing the drivers of the transition. Based on the objective, one main research question is formulated as follows:

1. What is the role of social innovations in the Finnish forest-based bioeconomy?

Since the main objective could be understood in various ways, three additional sub-questions are specified. The following three questions aim to create understanding on the role of social innovations:

1.1 What kind of theoretical and conceptual framework is needed for sustainable transition considering the value chains of packaging and wood construction?

1.2 What kind of innovation paths have the wood construction and packaging board value chains followed during the past 20 years?

1.3 What kind of economic, environmental and social drivers can be found behind the innovation trends?

The selected research method for this thesis is qualitative case study. Case study is performed for two different value chains, packaging board and wood construction. The selected value chains fit into a wider context of Finnish forest-based bioeconomy, possibility to generalize the results for an even wider global context is assessed as well. In this thesis, the theoretical framework is described first, and then a tool for collecting observations is created based on the framework. This tool is essentially a set of data collection templates, which are created from the described theoretical framework based on scientific articles. The structure of the thesis is illustrated below in figure 1. The sub-question 1.1 is answered first, by describing a theoretical framework for the thesis. The case study part aims to answer the sub-questions 1.2 and 1.3, by examining the two value chains shown in blue background.

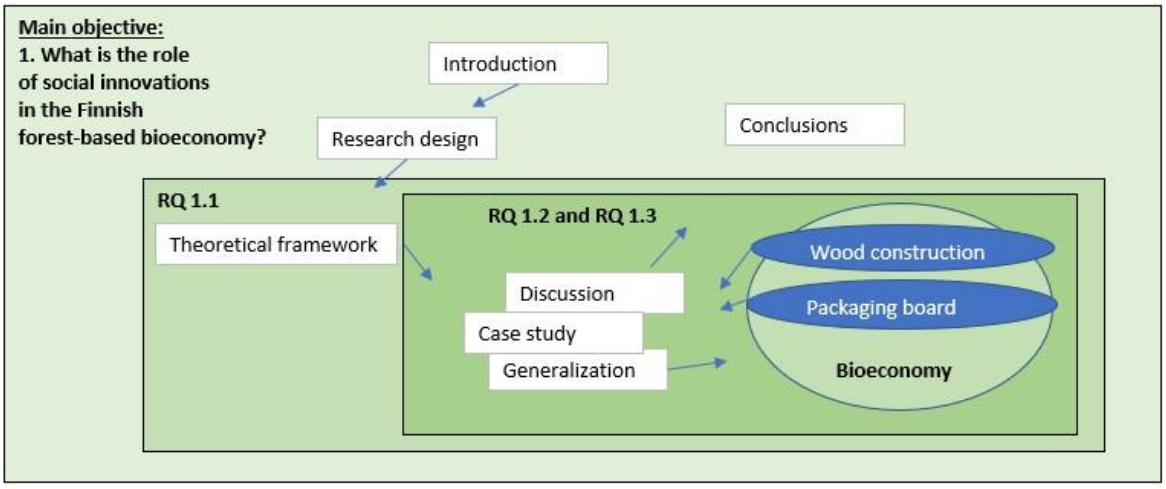

Figure 1. Illustration of the research structure

The theoretical framework is illustrated in figure 1 as a fence, which restricts the analysis of the next sub-questions. In addition, generalization is necessary to the wider bioeconomy concept achieves the main objective to understand the role of social innovations in the Finnish forest-based bioeconomy.

2.2 Case study methods

The qualitative analysis process can be divided into two parts, reduction of the observations and solving the puzzle. Though in practice, these parts are entwined, they can be analytically separated for explaining the process which takes place. (Alasuutari 2011).

Reduction of the observations can be further divided into two steps: 1) making observations from the materials only in the selected methodological or theoretical viewpoint and 2) combining the observations. The former is achieved systematically in this thesis by creating and using a collection template. Use of a systematic collection template aims to create explicit view on the observations. The latter means combining the observations into one or few main observations. This combining should be done by finding common rules which apply to all observations without exceptions in the available material. Any exception found to the rule from the material makes the combining not valid. (Alasuutari 2011).

For solving the puzzle, it should be noted that the observations are not considered as results, but only as clues which allow discussion on the real world behind the observations. This differentiation between observations and clues is a difficult task, but also the differentiator between a study and a survey. As Alasuutari (2011) mentions in his book Laadullinen tutkimus 2.0, a publication showing that votes for certain party have declined from the previous election, is a survey. Whereas looking behind the observation and making empirically justifiable inferences on what this tells about the society, would make it a research. For achieving the objective of this thesis, it is necessary to look behind the observations and understand better the role of social innovations in the Finnish forest-based bioeconomy. The discussion on the case study aims to look behind the observations and further elaborate the findings. Validity and reliability of the results are assessed together when the inferences are described. (Alasuutari 2011).

2.3 Materials

The sources for this work include public, secondary data, from literature, scientific articles and other materials from internet sources. The other materials include, for example, web pages of companies and different governmental and non-governmental organisations. The selection of sources is based on making observations from the data and using the most relevant sources. The list of used sources, separated according to research questions, are presented below in table 1.

Table 1. List of sources for the case study

RQ	1.1 Framework	1.2 Innovation paths	1.3 Drivers
	Mikkilä et al. , Oliver et al. 2014, Bosman&Rotmans 2016, Geels&Schot 2007, Geels 2014, McCormic&Kautto 2013, Phills et al. 2008,	Company pages (seperate list below), Tilastokeskus, VNK, rakennustaito, YM, TEM, Toppinen et al. 2018 , Sitra, pakkaus.com, Joensuun yliopisto, Karelia AMK, VATT, Metla biotalous.fi, kiinteistölehti, rakennuslehti, Luke, Tekniikka ja talous,	Sitra, Metla, Turun kauppakorkeakoulu, EU, VTT, Tapio Oy, metsäkeskus, puuinfo, SMY, MTK, MHY, Metsäteollisuus Ry, Yle, Pakkausteollisuus, PTT, PEFC, FCS, PTR, Pakkausyhdistys, puunjalostusinsinöörit, wwf, greenpeace, Jyväskylän yliopisto

Table 1 gives an overview on which kind of sources are used in this work, below in table 2 are the innovation path research question 1.2 sources listed with references found in the end of this thesis.

Table 2. Sources and used references for the innovation paths research question

	1.2 Innovation paths
Source	**Reference**
Tekniikka ja talous	T&T 2005.
Puunjalostusinsinöörit	Huuskonen et al. 2013
TEM	TEM. 2014. TEM. 2017. Loukasmäki 2016
LUKE	Luke 2017, Luke 2018
Rakennuslehti	Rakennuslehti 2017
Kiinteistölehti	Kiinteistölehti 2017
Metla (now part of luke)	Heräjärvi et al. 2017, Muilu-Mäkelä et al. 2014
Biotalous	Biotalous 2018.
VATT	Junka 2010
Rakennustaito	Karjalainen 2017a
Sitra	Tainio 2004
Karelia AMK	Matveinen 2014
Joensuun yliopisto	Niskanen et al. 2008
Pakkaus.com	Säilä 2018.
Statistics Finland	Tilastokeskus 2017, Tilastokeskus 2018
VNK	VNK 2018
	Toppinen et al. 2018

The innovation path sources above, are used also in the qualitative study, in a sense that conflicting observations were searched considering drivers recognized in research question 3. Similar table for the research question 1.3 sources and used references is presented below in table 3.

Table 1. Sources and used references for the research question 3 considering drivers

1.3 Drivers	
Source	**Reference**
wwf	WWF 2017.
greenpeace	Greenpeace 2018.
pakkausyhdistys	Säilä 2018.
PTR	PTR 2017.
PTT	Haltia et al. 2017
PEFC	PEFC 2018
FCS	FCS 2018
Pakkausteollisuus	Pakkauslaakso 2018
Yle	yle 2018
SMY	SMY 2018
MTK	MTK 2018
MHY	MHY 2018
Metsäteollisuus Ry	Metsäteollisuus 2018.
Puuinfo	Puuinfo 2018a, Puuinfo 2018b
YM	YM 2013, YM 2018, Karjalainen 2017b
Metsäkeskus	Metsäkeskus 2018
Tapio Oy	Koistinen et al. 2015
VTT	Nykänen 2017, Hyytinen 2005
EU	94/62/EC, 2016/C 075/06, EC 2012, EC 2018
Turun kauppakorkeakoulu	Ahvenainen et al. 2009
Metla (now part of luke)	Heräjärvi et al. 2017, Muilu-Mäkelä et al. 2014
Sitra	Korkman&Greene 2017
Jyväskylän yliopisto	Lehtonen&Uusitalo 2011

For the case study methods, the following references were used to design the work: Alasuutari (2011), Eskola&Suoranta (1998) and Yin (2014).

In addition, resources and information was gathered from the web pages of following companies (in no specific order): Westas, Stora Enso, Kotka Mills, UPM, Metsäwood, Koskinen, Versowood, Lapwall, Arcadia, SRV, Salama.

3 THEORETICAL FRAMEWORK

The theoretical framework describes, based on published scientific articles, the relevant theories for assessing sustainable transition. In addition, concepts such as social innovations and grand societal challenges are described. The used concepts may have a variety of different meanings depending on the context. Therefore, the theoretical framework chapter attempts also to explain how these concepts are understood in this thesis. Finally, the selected concepts in focus in this thesis are operationalized and qualitative framework for the case study is created.

3.1 Social innovations

Social innovation is used in many different meanings and the use of the term has not yet been clearly restricted. Since this thesis focuses in the role of social innovations in sustainable transitions, definition needs to be clarified. The aim is to increase transparency on what is considered a social innovation in the case study part of this thesis. This thesis takes influence for social innovation definition from Phills et al. (2008), considering social innovation as best construct for lasting social change. More accurately, social innovation was defined in their work: "*A novel solution to a social problem that is more effective, efficient, sustainable, or just than existing solutions and for which the value created accrues primarily to society as a whole rather than private individuals*". (Phills et al. 2008.)

Furthermore, this thesis adopts the meaning of so-called normal innovation, or shortly innovation without any prefix, from Phills et al. (2008) to mean novel processes or outcome which fulfils two conditions. Firstly, innovation is not necessary original idea, but the result is new to the context or group which it concerns. Secondly, to be called innovation, the novel solution needs to be in some way better than the old process or outcome which it replaces. This thesis also distinguishes social innovation from the normal innovation with the idea from Phills et al. (2008), that in social innovation the value is created primarily to the society. Therefore, innovations such as deodorant, pharmaceuticals or computer are distinguished from social innovations. All these mentioned innovations do carry with them social value and benefit the society. However, since the value is not clearly leaning to society, but rather

to the business, these are not considered purely social innovations in this work. The term social innovation in this thesis is reserved to mean idea on creating a solution with value to society which would not otherwise be created if social benefits would not be the focus. To implement the idea of social value, some other types of innovations could be necessary. The restriction follows again from Phills et al. (2008) arguments, where it is considered that society is well equipped to produce these so-called normal innovations and separate term is useful for values which would not occur otherwise. (Phills et al. 2008.)

3.2 Multi-level perspective

The multi-level perspective allows observing transitions in three different levels. These levels are the socio-technical landscape, socio-technical regime and niche innovations. Socio-technical landscape transition is driven by macro-level trends. The landscape changes take usually place slowly and are affected by cultural patterns, political developments and macro-economics. The second level, the socio-technical regime, represents the aligned actions of the industries and actors. In the socio-technical regime, the trajectories are stabilized by rules and standards, long-term investments, competencies and cognitive routines which create solutions for sustaining the current systems. Therefore, the socio-technical regime has inertia which supports the system and its current development trajectories. The niche level is the so-called incubator room which creates novel ideas and pressures towards the socio-technical regime. (Geels & Schot 2007.)

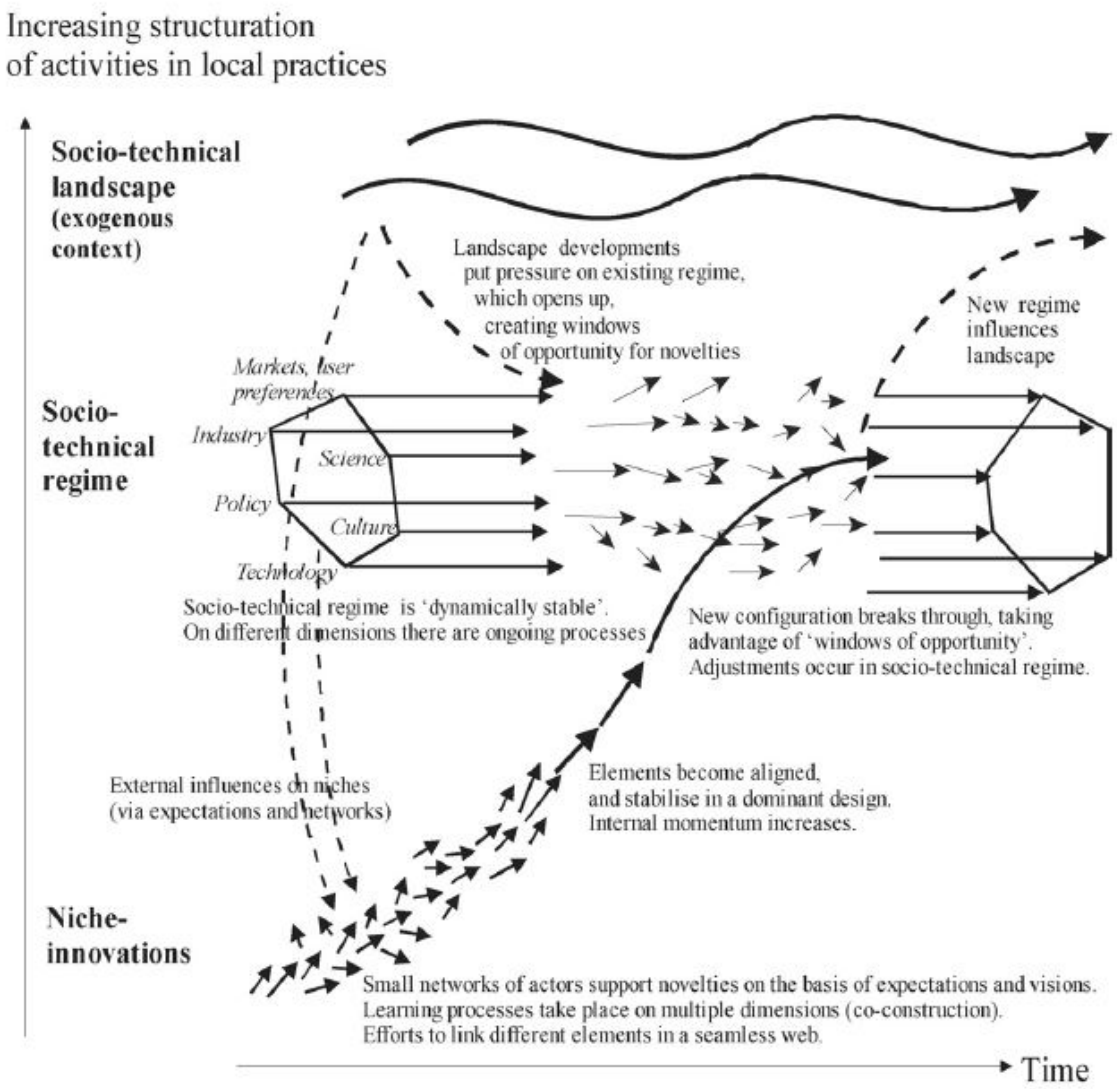

Figure 2. The multi-level perspective of socio-technical regime transition (Geels & Schot 2007.)

When the landscape changes cause turbulence for the socio-technical regime and there are available market-ready niche innovations, the window of opportunity may cause transition in the regime. These transition pathways have been studied and several pathways have been identified. The transition pathways vary from niche solutions replacing the regime completely to configurational adaptations which allow the current systems to take certain elements from niches. The traditional example of system transition is the replacement of sailing with engine powered ships, when the existing sail industry created larger and larger sails and added masts to ships for sustaining the current trajectory. Eventually the niche engine business took over and the industry regime changed. In this thesis the MLP, as visualized below in picture 1 by Geels and Schot (2007), allows understanding the role of

the niches and socio-technical regime dimensions in the sustainable transition. When trying to understand the development of bioeconomy in Finland, the landscape pressures, socio-technical regime and niche innovations have all affected use of woody biomass for bioenergy as well as packaging and wood construction value chains. (Geels & Schot 2007.)

Considering the MLP, four different transition pathways for socio-technical regime have been proposed. These are called transformation, reconfiguration, technological substitution, and de-alignment and re-alignment. In addition, fifth transition pathway is acknowledged when the transition takes place in combination of the previous four. It is also possible for industry regimes to sustain current development trajectories, thus preventing or delaying the transition. Therefore, reproduction process is defined to represent the case where regime remains stable. (Geels & Schot 2007.)

The industry regime may reproduce itself, when the landscape is not causing pressures and the niche-innovations are not able to succeed. Therefore, the industry regime is considered to have the ability to solve problems internally in the regime, reproducing itself through regular development trajectories. Such regular developments take place under the existing rules and norms with high predictability. Regular developments include product development, market competition, take-overs and mutations. (Geels & Schot 2007.)

Transformation path takes place when landscape exerts moderate pressures towards regime, but the niche-innovations are not ready for markets. In this case, regime modifies direction of developments. Transformation pathways are marked with social activity aiming to change industry norms and evolutionary dynamics with creation of new technical variations. These variations, and mutations from them, cause the regime to change from inside, new regime is created from the old one with reorientations and adjustments. The regime actors survive, but their social networks may change, and they may absorb some of the niche-innovations to sustain existing structure. One example of transformation is found from the end of 1800's and beginning of 1900's. During that time, Dutch replaced the cesspools with water pipes for hygienic reasons. The transition started as a civil movement by doctors already in the 1850's, but change took place incrementally rather than disruptively. Certain technical variations were needed, but much of the technology existed. However, the industry regime

took incremental steps, where first dry-collection systems and pneumatic systems for human excrement collection were tried. By 1893, the sewer systems were implemented in Hague and 1914 in Amsterdam, as the civil movement and increasing importance of health to people continued to cause pressures. (Geels & Schot 2007.)

De-alignment and re-alignment transition is caused by avalanche type sudden and large change in the landscape. Therefore, the industry regime is de-aligned when it's not able to respond properly to the changes in the landscape. When there is no clear niche-innovation to take place of the old regime, multiple niches will compete for domination. Once the dominating niche is found the new regime is formed around it for re-alignment. Example of this transition process is the replacement of horse-drawn carriages to automobiles. In this case, several issues were caused by the existing industry regime and landscape pressures existed in large scale. Several niches competed for being the new method of transportation and automobile became dominant. (Geels & Schot 2007.)

Technological substitution is the case, where niche-innovations are ready for markets when large landscape pressures exists. This is followed by niche-innovations replacing the existing regime. This type of situation is caused, when industry has inertia or otherwise keeps stable and the market-ready niche innovations are waiting for window of opportunity. Example of technological substitution is found from the case mentioned in previous chapters, when engine powered ships replaced sailing ships. Sailing ship industry was able to produce larger sails and add new masts for a long time, before landscape pressures caused engine powered ships to substitute sailing ships. These landscape pressures included, for example, trans-Atlantic passenger market expansion due to emigration to America and political revolutions. (Geels & Schot 2007.)

Reconfiguration is a process where innovations are developed in niches and are adopted to the regime to solve problems. When the innovation fits in to the existing system, it is accepted as an add-on component which does not change the rules of the existing regime. When new innovations are adopted, it may create demand for another innovation and this way the components are added to the existing regime. Therefore, the new system is created by multiple innovations following each other. The difference to transformation process is

that the basic structure of the regime is changed in the reconfiguration. Example of reconfiguration is the industrial development from traditional factories to mass production. The new tools and power machines were adopted as they were developed, which eventually changed the structure of manufacturing industry. It is also possible that a sequence of the different transition mechanisms occurs. In this thesis, the transition pathways are used in the discussion of the case industries. (Geels & Schot 2007.)

3.3 Triple embeddedness framework

The term triple embeddedness framework is coined by Frank W. Geels (2014). This framework creates understanding on how industries and their environments co-evolve and have bi-directional interactions. The development of the framework was motivated by new topics emerging in the innovation study field, such as the grand societal challenges and socio-technical transitions. Specific problem behind TEF is that previous frameworks in innovation studies were not suited to address the issues relating to industries solving societal problems. It is recognized that large and powerful firms can play an important role in solving grand societal challenges with innovations. However, these industries have sunk investments, experience risks from radical innovations and lack of incentives for solving the issues. Therefore, pressures are required from the external environments for increasing interest towards radical innovations in these industries. (Geels 2014.)

The triple embeddedness framework describes firms-in-industries as embedded into two external environments, which are socio-political environment and economic environment. TEF framework is presented below in figure 3. In addition, firms-in-industries are seen embedded in an industry regime mediating actions toward the external environments. For understanding the external pressures on industries from the environment, TEF draws ideas from evolutionary economics, neo-institutional theory and economic sociology. These can also be called selection theories. Considering adaptation theories, TEF includes both externally- and internally-oriented strategy approaches, which describe the firms-in-industries strategical choices. The bi-directional interactions between the external environments and firms-in-industries can be described with the framework combining these multiple dimensions. (Geels 2014.)

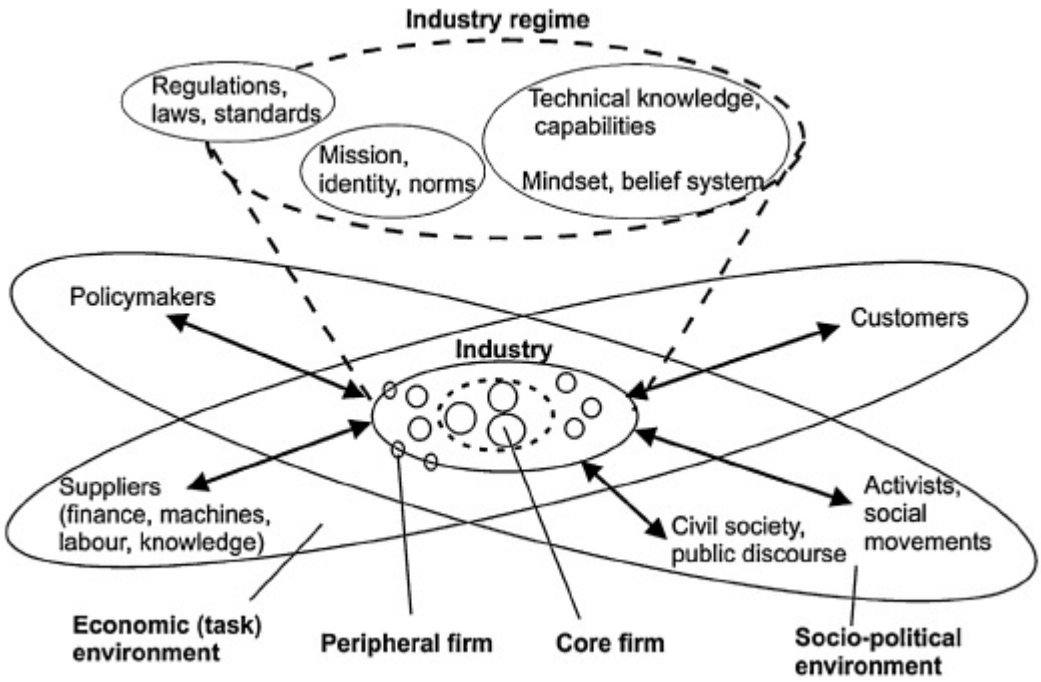

Figure 3. The triple embeddedness framework (Geels 2014.)

In this thesis, the two industry regimes are wood construction and packaging board. These industries are especially integrated in the upstream of the wood manufacturing and packaging board value chains. Due to the strongly integrated manufacturing and raw material acquisition streams, the industry regimes and environments of the case industries are interrelated though not completely similar. In the figure 3, the left side of the economic environment corresponds to upstream production and right side the downstream consumption. As production and consumption transitions take place, the industry regime actions and choices change while peripheral and core firms compete in the markets. The peripheral firms are the firms which are not the core players of the industry and may represent lower power. Core firms are the dominating firms which aim to keep their position and use their power in the industry regime for shaping suitable business environment for their operations. This may take place in interactions with the socio-political environment. Policymakers and civil society may give pressures to the industry, but also the legitimate the industry actions. (Geels 2014.)

For this thesis, TEF allows systematic way of assessing the balances between the external pressures towards the case industries and the case industry strategical actions. In addition, TEF includes different stages for industry transition. When the external pressures are small, routine reproduction processes allow the industries to maintain development trajectories. However, when external pressures are increasing and accumulating, more fundamental changes are required. Finally, this may lead to change in beliefs and mission of the industry, forming new industry identity where new technologies and strategy dominate. In figure 4, the summary of strategic reorientation stages is presented. It should be noticed, that technology and capabilities are easier to change compared to beliefs and mission. (Geels 2014.)

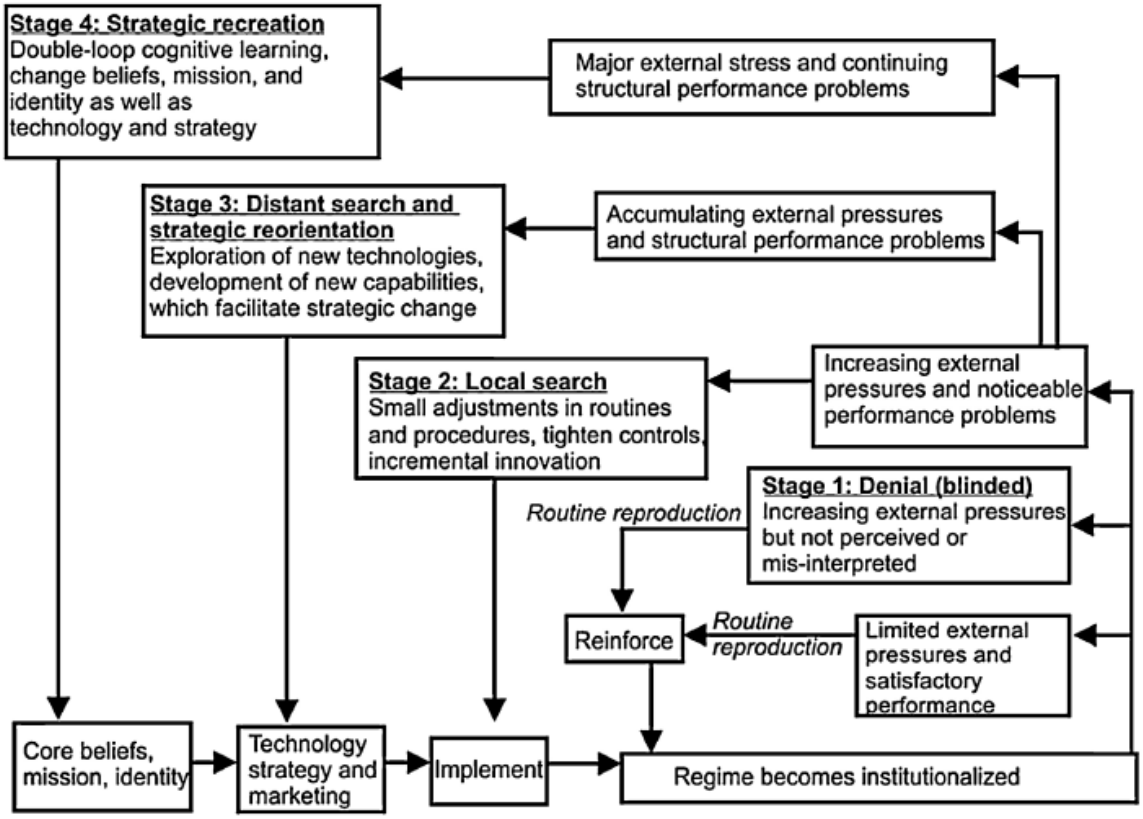

Figure 4. Summary of the stages of strategic reorientation (Geels 2014.)

When assessing the innovation paths, it could be useful to understand which stages of the strategic reorientation the industry has experienced or is currently experiencing.

3.4 Theory operationalization

The task of theory operationalization involves creating a set of operational measures which can act as qualitative indicators. First, variables which represent the observed concepts are selected. Secondly, the qualities, which can be measured by examining the collected evidence, need to be assigned for each variable. The purpose is to create a qualitative matrix where the evidence can be collected, and which can then be analysed for answering the research questions. In addition, these operational measures are created so, that they are supported by the theoretical framework described by the previous chapters. Therefore, in a stepwise manner, next the operational measures for answering each of the research questions and their linkages to the theoretical framework are described. Keeping the case study as operational as possible, requires simplification of the ideas into a handful of indicators.

The first research question involving the needed theoretical framework doesn't require operational measures, but rather this research question is answered by the theories described previous chapters and their operationalization. The second research question requires operational measures, as the task is to describe what kind of innovation trends the value chains have followed. Therefore, it is necessary to choose the indicators presenting innovation trends.

The innovation trends are discussed in the MLP and TEF context. The multi-level perspective allows categorizing the transition depending on the transition mechanism. On the other hand, TEF provides the ability to look at the drivers behind. In the TEF context, this thesis looks at the external pressures and internal strategic decisions which the industry has communicated. This way, it is possible to assess the reorientation stage. Externally, economic and socio-political environments are described by supplier and customer pressures in social, economic and environmental dimensions. Internally, the current missions and technologies are in focus. In addition, the external pressures and internal reorientation estimations are divided along the value chain to understand if the drivers are equally aligned through the value chain.

Starting with the MLP transition pathway, the development of the industries is described in this thesis in six dimensions, including mission, capabilities, technology, performance, networks and innovation. These dimensions are used to define the studied industry regimes. Especially, the change in each of the dimensions prior 2010 and after 2010 is in focus. The landscape pressures in the MLP context are observed in social, economic and environmental dimensions for both time periods. The landscape pressures in each of the sustainable development dimensions can have values of low, moderate or high. Finally, the niche innovations are studied based on market readiness and competitiveness of the niches. Assessing the market readiness of the niches is critical in determining the MLP transition pathway, i.e. are the niche products ready to replace existing system. The competitiveness of the niches describes if the niches are aligned into certain type of system or are the niches competing against each other. The qualitative matrix described later explains the use of this operational measures in detail.

After describing the transition pathway of the case industry, the question remains what kind of drivers can be found. The drivers in this study are understood according to the TEF as bi-directional interactions between the firms-in-industries and the two external environments. Therefore, the pressures exerted from social-political and economic environment are observed. These pressures are further divided as pressures from the civil society, policymakers, customers and suppliers. Furthermore, the pressures are divided in social, economic and environmental pressures. For understanding how the industry is acting under these pressures, the reorientation stages are estimated for the case industries. In addition, the industry value chains are divided into three categories: upstream, middle and downstream. The division of the value streams is made specifically in the case study chapter when the value streams are presented and the qualitative assessment matrix is described in dedicated chapter below.

3.4.1 Qualitative framework

To be able to answer the research questions, the previously described theories need to be constructed into a systematic framework for qualitative analysis. The second research question concerning development trends requires further analysis on what kind of developments are in focus. For this thesis, the development trends are analysed in

environmental, social and economic dimensions. The development trends are structed in two parts, before 2010, and 2010 onward. Each of the dimensions is also divided according to the multi-level perspective in the landscape, industry regime and niche levels. The qualitative matrix presented below in table 2 enables discussion on the economic, social and environmental drivers behind the innovation trends.

Table 2. Qualitative assessment matrix for MLP transition pathway

MLP	< 2010	> 2010	Transition pathway
Industry	Mission: Capabilities: Technology: Performance: Networks: Innovation:	Mission: Capabilities: Technology: Performance: Networks: Innovation:	
Landscape pressures	Social/ environmental/ economic [low/moderate/high]	Social/ environmental/ economic [low/moderate/high]	
Niches	market readiness, competing or aligned	market readiness, competing or aligned	

For further examining differences along the value chain, second analysis matrix is created where value chain is splitted into three parts. The matrix generated on the basis of TEF is presented below in table 3.

Table 3. Qualitative assessment table based on triple embeddedness framework

		Pressures from external environments			
		Economic environment		Socio-political environment	
Value chain	Reorientation stage	Supplier	Customer	Policymakers	Civil society
Upstream		Social: Environmental: Economic:	Social: Environmental: Economic:	Social: Environmental: Economic:	Social: Environmental: Economic:
Middle		Social: Environmental: Economic:	Social: Environmental: Economic:	Social: Environmental: Economic:	Social: Environmental: Economic:
Downstream		Social: Environmental: Economic:	Social: Environmental: Economic:	Social: Environmental: Economic:	Social: Environmental: Economic:

The matrix in table 3 allows to analyse the pressures from external environments and relationships in the industry regime. Using two different frameworks for the case study also generates redundancy and allows discussion on what kind of results were found with using either MLP or TEF.

The simplified model of the value chains explains how the upstream and end-of-life for the two case industries are connected. The more accurate value chains are presented in the case study, but for the assessment the value chains are simplified and classified according to figure 5.

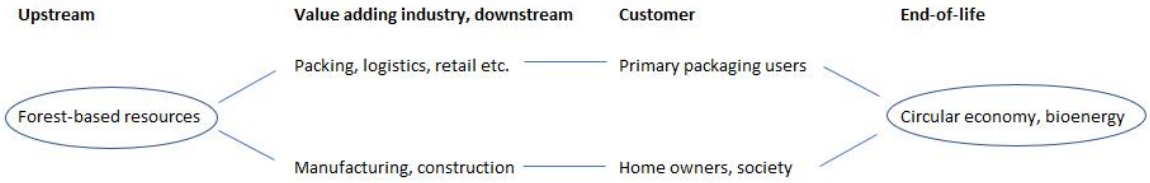

Figure 5. Simplified model of the value chains for two case industries

3.4.2 Financial dimension within social innovation

In this thesis it is taken for granted that social innovations may lead to financial profitability. The financial potential of social innovation is left in this thesis as topic for further research. The previously described clear-cut distinction between financial profitability and benefits to society is difficult to estimate in all cases. When all the intentions and added values for all parties involved are not stated, it becomes difficult to estimate if value was leaned clearly towards society as a whole. Therefore, attempt is made here to distinguish from each other the ability to create financial profitability 'from' social innovations and the ability to create financial profitability 'with' social innovations.

Example of this distinction could be taken from Finland, the low-cost cell phones manufactured by Nokia. These low-cost cell phones allowed the availability of the technology for low income groups and created financial value for Nokia. We could call the

low-cost cell phone in this case as financial profitability 'with' social innovation. Whereas selling the next generation phones or new cell phones to this created customer segment as financial profitability 'from' social innovation. In this case, this thesis does not try to estimate if in the beginning the value was leaned towards the society as a whole or towards Nokia's financial profitability, but we could compare if the value was created directly by selling volume product or indirectly by creating new business segment. Therefore, this thesis would take the following three-step approach in understanding the nature of Nokia's innovation: 1) Equal availability to communication technology is a social innovation, 2) Creating a differentiated product offering with low-cost cell phones is a means to create financial profitability 'with' social innovation, 3) selling next generation phones to this new business segment is creating financial profitability 'from' social innovation.

In the similar manner, when Phills et al. (2008) determined that deodorant is not a social innovation, this thesis would consider again using the additional terms 'with' and 'from': 1) Solving the issue of unpleasant odours for increasing preference to social meeting is a social innovation, 2) Creating deodorant product and selling deodorant for increasing social value is creating financial profitability 'with' social innovation, 3) Selling deodorant since everyone uses it, is creating financial profitability 'from' social innovation. This approach seems also useful for the cases of this thesis, primarily because it allows some, though vague, level of understanding on the adoption stage for social innovation. This seems to allow distinguishing also technological innovations as a tool for social innovation, which is useful for separating the two. Any of the social innovations described previously in this thesis, could had been achieved by other technological solutions. It just seems that, low-cost cell phone and deodorant were found as the best technological solutions for solving the issues. These social innovations also seem obvious today but were still new ideas once. Both solving the equal availability to communication technology and mitigating the issues with bad odours also required technological innovations for implementation. Some other technological solutions, like clothespin to nose could have solved the issues but the better solutions prevailed in the market. While clothespin to nose seems ridiculous, it should be noted that similar solutions exist in many industries, for example, personal protection masks for air pollution are used every day in many places.

In addition, technological innovations are not the only solution, other systematic changes may solve issues without technology. Before choosing the correct solution, the social benefit which is desirable should be first defined. This could allow higher level of legitimacy for the technological solution than developing a gadget and trying to sell it. Understanding first the social innovation, allows to understand if new technologies need to be developed, or if using the existing technologies in a new way offers solution. This is similar to a business which is solving a problem of the customer. First the problem needs to be understood, then it needs to be solved and technology created if it doesn't exist. The providing business also needs to settle the value which the product or service has for the customer and capitalize on this delta. The social innovation framework adopted for this thesis is presented below in figure 6.

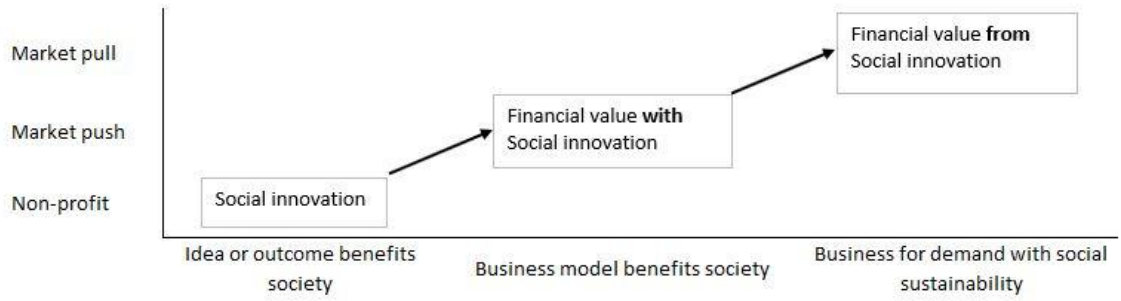

Figure 6. Illustration on the connection between social innovation and financial profitability

It should be noted that is not always necessary that the same actor creates the social innovation than who creates value with or from it. For example, social value could be developed by cross-sectional partnerships, meaning public, private and NGO partnerships or with any combinations of these. With these distinctions, it seems that cross-sector collaboration may lead to social innovations more effectively than business approach. There may be a group of social entrepreneurs who aim to look first social value, but for most parts companies have tendency and obligation to shareholders to focus in steps 2 and 3. Therefore, companies looking primarily at steps 2 and 3, might not succeed in defining first the social innovation. Therefore, cross-sectional partnerships could offer businesses opportunities in creating financial profitability 'with' and 'from' social innovations, while social innovation creation is outsourced to external stakeholders and cooperation bodies including certain persons from firm. This would in practice mean from business perspective, giving support

for social innovation activities in cross-sectional partnerships and expectations to create demand for products or services which are needed for condensing the social value. Social innovation value to the society as whole could sometimes depend on business involvement, as in the case of low-cost cell phone, or the value could be created by public means. Though we are not here separately categorizing innovations, it should be noted that innovation is not restricted to products. Innovation could be also organizational innovation, for example negotiation of framework agreements between labour unions and employer representatives was once a social innovation. In addition, technological innovations may become social innovations when new products contribute to sustainable development of society or otherwise increase wellbeing by creating new systems. It is also possible for users or community to create social innovation by using technological innovations in some new way to create social value. Social innovations may also aim at solving some of the grand societal problems which our modern society if facing. Social innovations could aim at increasing equality among society, for example by providing healthy living conditions equal for all. Food security and climate change are considered some of the most pressing grand societal challenges. Therefore, developing new sustainable materials for packaging or providing construction materials contributing to climate change mitigation could become social innovations. According to this framework, it follows that creating sustainable business from social innovation would require at least the following steps: 1) Define social problem or issue to be solved 2) Social innovation 3) Creating business model and increasing impact from social innovation 4) Social innovation becomes the new system and creates demand for profitable business. These four steps are presented below in figure 7.

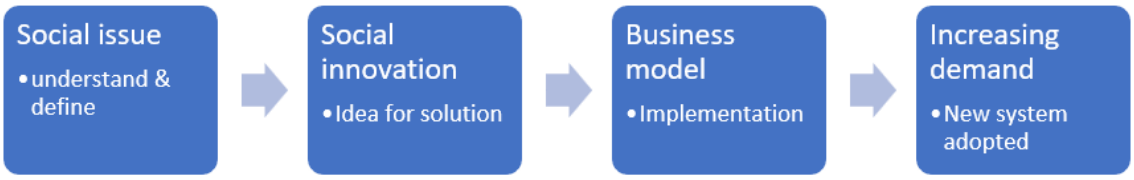

Figure 7. Role of social innovation clarified in a simple process diagram, from social issue to adoption of the solution (created for this thesis)

Though clear hypothesis is not created on the current situation of the case study business environments, it seems, in light of the available evidence in this thesis, that a lot of discussion involves defining social problems (step 1) and creating business models to solve social issues (step 3), but less discussion involves actually creating social innovations (step 2). Now, let's assume, that definition of the social problems takes place in horizontal cooperation with public institutions, research institutes and NGO's, while start-up's and other companies are trying to implement the solutions with new business models, products or services. If this would be the case, then the challenge would be to increase communication between these two levels. This way new business models could better receive legitimacy if they would be based on clearly defined novel solutions.

4 CASE STUDY

The qualitative case study in this thesis is made on two value chains, packaging board and wood construction. Both value chains use forest-based raw materials. Therefore, the upstream of the value chains is analysed in the forest-based bioeconomy context.

4.1 Wood construction value chain

In the year 1960, as high as 93,4 percent of buildings in Finland were constructed of wood. The percentage decreased during the coming decades to 80 percentage by 2000. By the end of 2016, from approximately 1,5 million buildings 80,6 percentage were made from wood, presenting a slight turn in wood construction (Tilastokeskus 2017). Today, wood construction finds the greatest opportunities in up to eight storey houses, public buildings, warehouses and industrial buildings, silos, yard construction and landscaping. In addition, upgrading façades in suburban houses and adding new storeys to excisting buildings presents opportunities (TEM 2017). Wood has several benefits over steel and concrete as a building material. Replacing concrete and steel with wood in construction and utilizing side streams to replace fossil fuels could save 14 to 31 percent of global CO_2 emissions (Oliver 2014). Current construction methods also cause high waste streams, 40 percent of global waste results from construction (Luke 2017). In addition, from natural resources used globally, around half goes for construction (Luke 2017). In Finland, in 2015 construction wastes accounted for approximately 14 percent of all municipal waste (Tilastokeskus 2017). Wood is also the only renewable material in construction (Luke 2017), with potential high impact to resource efficiency.

CLT technology (cross-laminated timber), uses layers of timber sheets glued crosswise providing wooden elements for vertical and horizontal load-bearing elements. Also beams made with LVL technology (laminated veneer lumber) provides structural wooden elements. Both technologies can be used for multi-storey buildings, offering air-tightens, easy coupling and good rigidity. The elements can be pre-fabricated, which allows time saving in the construction site offering up to 60 percent shorter construction times (TEM 2017). An additional benefit was mentioned by Stora Enso, suggesting that CLT constructed buildings allow for up to 10 percent more living space compared to traditional buildings (StoraEnso

2018). Wood construction is specifically preferred also in earth quake prone areas, due to the quakeproof construction that good flexibility wood construction provides.

Fire safety is good in wood construction, CLT element surfaces become charred when fire occurs, thus protecting the core of the element and maintaining structural strength (Biotalous 2018). In wood construction, also gypsum plates may be used, which slows temperature rise on the other side of the plate when crystallized water vaporizes in the gypsum during fire (Puuinfo 2018a). Gypsum plates used to be mandatory, but other improvements in fire safety have made it possible to remove this restriction and residents can now enjoy the exposed wooden surfaces. In addition, buildings constructed with wood are equipped with sprinkler systems for fire extinguishing in Finland. Fire safety improvements also make buildings tightly sealed, which increases energy efficiency. (Karjalainen 2017a).

Wood construction has several social benefits, for example employment opportunities as well as cultural and historical value (Puuinfo 2018b). Health impacts of wood have also been studied, though more research is needed since these mechanisms are not yet understood fully. Evidence of wood health impacts have been found due to the positive effect for indoor climate and stress relieving restorative effects. Wood keeps the indoor climate relative humidity and temperature distribution steady due to its ability to absorb and release water when conditions change. Wood also has good antibacterial properties, especially pine. Some proof also exists for positive effects to stress levels and immune system activation from the volatile organic compounds from pine, such as alfa- and beta-pinenes. Psychophysiology studies the psychological impacts to physiology. It has been found that rooms with wooden elements in decoration lowers stress, this has been studied for example in school environment. In nursing homes, wood materials have been found to increase social activity and the observation ability of the elderly people. Most people have positive relationship with wood and, for example, touching natural materials calms people. More multidisciplinary human research will be needed, but accurate scientific information on the restorative effects could impact the usage and market value of wood. (Muilu-Mäkelä et al. 2014.)

In addition, wood also has good acoustic properties, providing good insulation from sound, thus improving living quality. There has also been improvement during the last 20 years for

these properties. In 2017 questioner in Finland, 21 percent of people living in wood buildings reported considerable amount of stepping noise from upstairs, compared to 80 percent in the end of the 1990's. It was noted however, that when the acoustic properties decrease other noise, then stepping noises and noises from far tend to become more irritating. 84 percent of responses found that wood buildings are by appearance and architecture good or very good. Furthermore, 76 percent thought that ecological factors will affect apartment choices in the future. For fire safety 98 percent considered fire warning systems improving safety and 96 percent thought also the same for automatic fire extinguishers. (Karjalainen 2017b).

Development of wood construction in Finland has long history of competition with concrete, and the development efforts have been compared to "pushing with rope" (Rakennuslehti 2017). Debates in the industry and institutional level have circled for at least 40 years around the environmental benefits of wood as well as accusations in favouring one material over another due to political reasons. Meanwhile, it seems wood construction innovations have been focused around lowering construction cost and technological improvements. These have been important factors in the niche product development and for winning projects from concrete industry. Perhaps due to limited resources and focus in gaining competitive price, some of the beneficial factors of wood have been developed less. Therefore, many of the wood buildings are lacking differentiation and seem same with the concrete buildings. This might have left Finland behind other countries in developing the national wood construction brand and design also necessary for the high value export products. Could it be, that by considering the positive effects of wood and bringing these more in the architecture and design would increase demand. For example, allowing open wooden surfaces indoors is one development into this direction from legislators and opens opportunities for designers to think the psychophysiological effects. Disrupting any industry requires often changes in the landscape of the society, which the industry has little or no influence. It seems that the behavioural landscape is moving towards sustainable thinking and living, and health values are increasing. The landscape and situation in the industry offer window of opportunity, but development stage of the niche products could determine if transition can take place. If the products are not considered suitable for the demand, the dominating industry finds ways to implement new objects to design which satisfies the demand without actual disruption. For example, concrete buildings can take sustainable elements and include wooden appearances

if the wood construction industry doesn't provide holistic market ready solution. This could still lead to some improvements, but the full benefits from wood construction would be delayed or the export objectives would be replaced with market ready import solutions. However, good cooperation in the whole construction field in Finland is necessary, since failures in any field could damage reputation of others as well. With proper development of the niche products and differentiation by positive social effects, the transition in the industry regime might take place even disruptively in multi-storey buildings. This differentiation could also bring competitive edge when locations of manufacturing are considered between countries. The market share of wood construction is already dominating in Finland for detached housing, there is great potential in the up to eight storeys buildings. Technological innovation paths should be complemented with innovations in social dimension. This would serve the changing landscape in the society. However, the change requires that traditional engineering community is open for holistic views on the society. Wood building construction has been delayed already in such a way, that the landscape might experience further changes before current solutions can reach proper market share.

4.2 Packaging board value chain

Packaging materials are used for convenient transport and protecting quality of contents. Considering food packaging, the important task is maintaining food security until the contents are used. Packaging materials after use become waste, which unproperly managed causes health risks and environmental issues. Rising population and consumption of products are increasing amount of packaging materials and resulting waste caused by unintentional and intentional littering. Together with solutions for decreasing amount of packaging use, packaging materials will face increasing demands for sustainability. Since packaging has the important function for protecting the food security, proper packaging decreases the amount of food waste. Therefore, sustainable packaging materials are needed to protect food security.

The different packaging solutions can be divided into primary, secondary and tertiary packaging. Primary packaging is also called the sales packaging, this is the package in which the consumer purchases the product. The secondary packaging, or group packaging, is used

to hold multiple primary packages, for example to optimize space in the storage self. Removing the secondary packaging doesn't affect the product to be sold. Tertiary packaging, also known as the transport packaging, is used as protection and convenience for handling in transportation. (94/62/EC.)

Packaging materials include glass, plastic, paper, cardboard, paperboard, metal and wood. Fibre based materials account for approximately 31 per cent of the value for the global packaging market (Stora Enso, 2014). Total use of packaging materials in Finland was approximately 1,8 million tons in 2015, including both reused and new materials introduced to market (YM 2018). In 2016, pulp and paper industry overall took approximately 56 percent of the total raw wood used in Finland (Luke 2018).

The waste management priority demands that primary means of reducing waste is to prevent generating waste and reduce its harmfulness. If preventing waste is not possible, waste should be reused, recycled or recovered, or used as a source of energy. Final means is to dispose the waste, for example by incineration or landfilling. Reuse means using products in their original form, whereas recycling involves using the material again for new products. Recovery may include also recovery for energy generation.

The use of multiple materials in a single packaging creates challenges for recycling, harmonization of materials in packaging design is an important step in improving environmental footprint of packaging. However, certain characteristics, such as moisture and oxygen permeability have demanded use of multiple materials in packaging solutions. Where forest-based bioeconomy can provide new materials to replace fossil raw materials, also research is focused in developing new materials.

The packaging value chain starts from the recycled and new fibres, which are used together with other raw materials for new packaging.

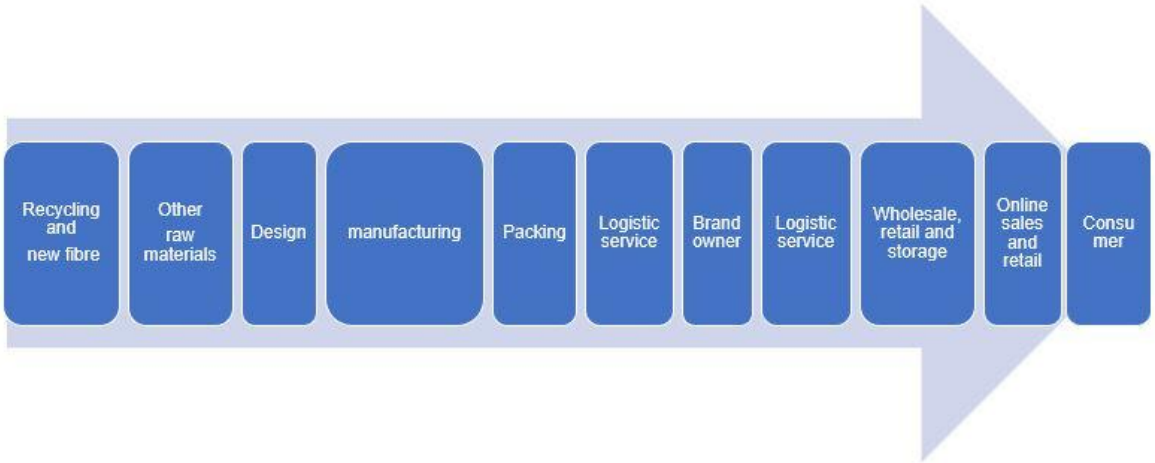

Figure 8. Value chain of packaging board

Here the acquisition of new materials has been excluded, since the harvesting and related logistic are in focus of several studies. In this thesis, the focus is on how the value chains have developed, what are the drivers and role of social and environmental innovations.

4.3 External environments and landscape changes

To better understand the development of the industry regime, it is necessary to understand what kind of developments are taking place in the landscape. In addition, the case study analysis requires building knowledge on the history and contemporary developments in the external environments.

4.3.1 Changes in the economic environment

In the 1980's main business players in Finland were largely owned by the government and banks. National ownership was marked with passiveness and actions were taken by owners primarily only after difficulties had already occurred. The change started from inside out, as companies started to be unsatisfied with domestic financial markets which caused competition in the banking sector, secondly companies moved their financial activities abroad, thus incrementally gaining distance to the national financial system. Thirdly, companies listed in the international stock markets received more capital and increased independence from the traditional owners. This transition led to changes in the leadership

strategies, during the 1980's production and business unit centric decisions dominated, but in the 1990's investor dividends, and shareholder value in general, became the primary focus of the board members. (Tainio 2004, 32-35.)

The Forest sector has followed similar development paths, while the change occurred a little later in the 1990's. Shareholder value gained importance latest when the large forest companies listed in the New York stock in the end of 1990's for increasing investor interests. This also led to requirements for structural changes, when the companies needed to find ways to gain investor attention. (Tainio 2004, 41.)

One example considering the volume of these changes is from the late 1990's. In 1997, the share of metal and forest industries in the government owned companies had a large shift, when the forest company Enso and Rautaruukki from metal industry became associate companies (Junka 2010, 9). This led to a decrease in the value of the capital stock of government owned industrial companies from approximately 800 million euros to approximately 400 million euros (Junka 2010, 11).

In the new millennium, the large investments made in paper production could not provide the expected profitability. The paper market was saturated with new production from Asia, US dollar was weak and the demand in Europe did not grow as had been estimated. At the same time the required rate of return remained at the peak years 10 – 15 per cent, neglecting the changes in the business environment. The forest sector companies were forced to cut business cost for increased ROI by organizational cuts and giving up on less profitable units in Europe and North America. (Niskanen et al. 2008, 32).

Since the new millennium started, the paper exports from Finland have continued to decrease due to the changes in the global business environment. On the other hand, cardboard and pulp product exports have had positive development. Paper export was approximately 7 billion euros in 1999 and little over 4 billion euros in 2016, while in the same time pulp exports have doubled from 1 billion to 2 billion euros and cardboard exports increased from almost 2 billion euros to approximately 2,5 billion euros (LUKE, 2018). It could be noted,

that the state-owned limited company Solidium in Finland holds still stocks in the forest industry in 2018, for example in Stora Enso (VNK 2018).

4.3.2 Innovation trends

Statistics Finland (Tilastokeskus 2018) gathers the current innovation statistics from companies in Finland every second year. The innovation statistic show, that the relative amount of companies having innovation activities in the pulp and paper industry as well as sawmills and wood product manufacturing has remained at the same level from 2004 to 2014. Innovation activity is relatively higher among larger companies than among smaller companies. Meanwhile, the reported impact from innovation activities relating to environmental benefits has increased greatly. The innovation impacts have shifted from widening product or service group and accessing new markets to gaining advantages relating to environmental benefits.

When looking at the paper, pulp and cardboard industry in 2012-2014, there were 42 companies in the industry that reported environmental benefits having large or medium meaning in commissioning innovations to use. From these 42 companies, the most important reason for commissioning innovations to use was high energy, water or material costs, with 66,1 percent reporting this reason. Improving company brand image and voluntary actions or projects for environmental benefits were the second and third most important reasons, with 65,5 percent and 63,2 percent. Present environmental regulation was mentioned fourth important reason with 61,4 percent. 45,3 percent of companies reported present or future demand for environmental innovations as the cause for bringing new innovations to markets between 2012 - 2014. Roughly this corresponds to 19 companies in the Finnish paper, pulp and cardboard manufacturing industry. Considering the bioeconomy framework, this figure seems modest. In fact, expected environmental regulations and taxes were also seen as more important reason for bringing innovations to markets than demand. However, when making conclusions based on the innovation statistics, it should be noted that also Statistics Finland mentions that no estimate of the measurement error can be given. The results of innovation statistics are based on interpretations of the definitions in the companies. (Tilastokeskus 2018.)

Between the years 2004 – 2006, approximately 70 percent of companies in pulp and paper industry reported innovation activities. For sawmills and wood product companies the corresponding percentage was almost 50 percent. In the years 2012-2014, approximately the same results were retrieved. Hence, during 2000's the relative amount of companies having innovation activities in these industries has not changed. The average relative amount of Finnish companies having innovation activities in the whole industry sector has also remained constant between 50 – 60 percent reporting innovation activity, leaving sawmills and wood product manufacturing approximately at average. At the same time, rubber and plastic product industries relative innovation activities have decreased from approximately 70 percent of companies reporting innovation activity in 2004 - 2006 to approximately 60 percent in 2012 - 2014. Meanwhile, innovation activities among computer and electronic companies have increased, the same applies for machine and equipment manufacturing as well as for chemicals and chemical products. It should be noted, that while 70 percent of companies in the pulp and paper industries reported innovation activities 2012 - 2014, new product innovations brought to market were reported by slightly over 50 percent of these companies. While all innovation activities are not expected to result in concrete results, the results are also explained by the fact that all innovations are not product innovations, the statistics separately classify also process, organizational and marketing innovations. The results show that the company size has effect on the relative amount of innovation activities and bringing new products to markets, when the company size is increased, the relative amount of innovation activity increases as well. From companies with over 250 employees in the industry sector, almost 90 percent reported innovation activities and approximately 65 percent of these companies brought new product innovations to markets between 2012 – 2014. (Tilastokeskus 2018.)

Considering the cooperation between companies, it also applies that increasing company size increases the amount of collaborative innovation. Between 2004 and 2006 approximately 95 per cent of industrial companies with over 500 employees reported collaboration with other stakeholders in innovation activities. For companies with less than 50 employees, between 50 and 60 per cent reported the same. Between 2012 and 2014, the collaborations in innovations or at least the reported numbers had decreased. In this later

report, 75 per cent of the largest companies reported collaborations in innovation activities. For smaller companies the share of companies reporting collaboration was 32 per cent. it was found that most often collaboration is done between the manufacturing companies and end-user innovation collaboration remained low. (Tilastokeskus 2018.)

4.3.3 Changes in production

During the 2010's, the business environment has been marked with new collaboration efforts between different actors, search for more diverse product groups and new business models as well as increased utilization of side streams for resource efficiency. New large biorefinery production plants have been opened and investors are searched actively from abroad for new projects which aim to increase the amount of higher value products and gain profitability from integration of pulp and paper production with energy generation and utilization of the side streams for new products. In addition, development work has shifted focus to the whole value chain from forest management to final products. Bioeconomy, circular economy, climate change mitigation and biodiversity risks have been the dominating context of the public discussion concerning forest sector, shifting the focus from the market economy discussion towards environmental benefits and risks. Simultaneously, the arguments concerning climate change mitigation potential and the sustainability of increased logging have received opponents. While the bioeconomy is now one of the spearhead projects of the Finnish government and the annual logging is increasing, the wide legitimacy in the society has not been yet achieved with environmental arguments.

4.3.4 Changes in consumption

Many of the grand societal challenges the world is facing can be linked to consumption habits and rising population. The current consumption philosophy has been adopted by the new rising middle classes in developing economies and the challenges relating to finite resources and imminent threats to ecosystems remain to be solved. However, the new generations of consumers increasingly integrate sustainability into purchase decisions. Sitra identified trends in leading edge and mass-market groups of consumers looking for

innovative solutions. They identified four changing behavioural themes and named four value territories for opportunities in creating new value in the markets with changing requirements. (Korkman & Greene 2017.)

The value territories were named flexible stuff, perfect stuff, stuff for pleasurable engagement and familiar stuff (Korkman & Greene 2017, 6-7). Assuming the leading edge could work as change agents for paradigm shift to sustainable consumption, these value territories could suggest that the so-called "green consumer" idea is developing into a consumer with holistic view on different dimensions of sustainability. The following value territories from Sitra publication all have integrated sustainability with the ideas, while quality and meaning of the objects is in focus.

Flexible stuff is identified as solutions group which allows individuals possibility to reduce volume of objects in life with multifunctionality and innovation while being planet friendly. It is important to notice, that this group still maintains the idea of owning and evidence of rising sharing economy was not found in the Sitra study. Perfect stuff refers to objects which are by design fit-for-purpose so well, that it reduces consumption by allowing selectivity of responsible consumer and has low- negative impact on the environment. Stuff for pleasurable engagement territory removes the guilt from pleasurable consumption by allowing luxury in sustainable way. For example, pair of sneaker made from ocean plastics is named as a product from this value territory. The fourth group is familiar stuff, which relates to products which evolve with the consumer, offering longevity and familiarity in the changing world. (Korkman & Greene 2017, 6-7.)

The quantitative part of the Sitra study included four markets, Finland, Germany, Spain and United States. The study found that among the leading edge group, 75 per cent were moving away from accumulating goods and were more focused on skills, knowledge and experience (flexible stuff). This was also the most commonly adopted leading edge group behaviour, though all four territories seemed relatively popular among the this leading edge. In addition, mass-market adoption of this behaviour was found as 33 per cent in the total four markets. Finland with 22 per cent presented slower adoption. Largest mass-market adoption in Finland from the four groups was for familiar stuff, with 35 per cent adoption. This means

that the stuff lasts longer and is repaired when necessary. Considering the combination of the four examined markets, the highest mass-market adoption was for perfect stuff, with 40 per cent reporting this behaviour. This means that much time is used to select product which will fit for purpose and will be used after purchase, the researches describe this behaviour with the term *hyper selectivity*. (Korkman & Greene 2017, 18-41.)

It seems that market opportunities for sustainable products are emerging. The development paths of consumer behaviour seem to support holistic views on sustainability. This offers opportunities for sustainable producers to make value propositions based on benefits in social dimension. Current focus on communicating environmental sustainability is important factor in consumer decisions but presenting solutions in social dimension could allow further legitimization of products, as wider consumer group is activated by these propositions. The solutions in forest-based bioeconomy are still in niche phase, but currently developing landscape in consumer behaviour could contribute to sustainable transition in the current industry regimes in, for example, packaging materials and construction. Therefore, reaching proper market share for these new solutions with market push, could allow preparing the products ready when consumer behaviour leads to market pull. Having the products ready for markets is important factor if consumer behaviour changes the landscape together with ideas relating to grand societal challenges. If the demand exceeds the ability to deliver for too long, this could cause other transition mechanisms to govern, leaving the industry regime less sustainable or delay the transition.

4.4 Qualitative analysis

The qualitative analysis compiles together the findings and inferences made. The qualitative framework matrices, which are described in the first chapters of this thesis, are filled based on the evidences found from different sources. The findings are described in this chapter briefly and discussion chapter aims to find generalizations by looking at both cases presented in this thesis.

4.4.1 Wood construction MLP

During the last two decades, wood construction landscape pressures seem to have increased in social dimension, but only from low to moderate. This observation is found also below in the qualitative matrix presented in table 4. The landscape and niche level are presented together in the same picture.

Table 4. Qualitative matrix representing landscape pressures and niche level developments in the wood construction context

MLP	< 2010	> 2010
Landscape pressures	**Social:** low pressures **Environmental:** moderate **Economic:** moderate	**Social:** moderate **Environmental:** moderate **Economic:** low
Niches	Competing niches which are not market ready	Aligned niches which are market ready (but lack of construction capabilities)

At least in the point of view of large-scale construction projects, low amount of policy drivers was present in the beginning of the millennium, which would have promoted use of wood. However, more policies have been implemented after this to increase use of wood. In addition, there have been increased hopes for taller wood constructions in urban areas. In addition, there is evidence of increasing amount of sustainable thinking among end-users which can later turn into higher demand for wood construction. In addition, the positive effects of wood and positive emotions experienced around wood surfaces could be factors for increasing demand. It seems that more studies and clarity on the impacts would be needed for these ideas. However, health is named among the grand societal challenges. In the short term, at least regional opportunities could be expected due to the coupling of health-related landscape pressures and positive perception of wood surfaces.

As seen in table 4, environmental landscape pressures are estimated to have stayed at the same level from the beginning of the millennium. Partly this is due to the selected categorization with low, moderate and high pressures as the options. To be more specific, climate change discussion seems as one of the main drivers for wood construction. These

discussions have intensified while the understanding of climate change related threats has increased. However, it is expected that the environmental pressures continue to increase. Since the developments in climate change mitigation seem modest, and consensus is forming on the long-term carbon storage in wood construction, this analysis leaves room for further increase in pressures in the environmental dimension. It is expected that with current trajectories, the pressures could further increase also due to the possibility of adverse effects to society caused by climate change. In addition, the interpretation of stable environmental pressures is supported by the higher construction waste streams, higher CO_2 -emissions during life-cycle and depleting raw-materials of the competitive materials. These environmental disadvantages of competing materials have been acknowledged without significant actions towards favouring wood. It is difficult to say based on the collected evidence, if only environmental drivers will drive large scale adaptation of wood construction in mitigation purposes, even if increased.

At the same time, economic landscape pressures towards wood construction seem to have decreased. This means, that before 2010 the forest-based raw-material use faced pressures and had to reinvent itself. This meant, for example, biorefineries with utilization of side-streams. In the upstream of the value-chain these pressures were higher, but in the downstream wood construction experienced lower economic pressure. This was mainly due to the availability of other established and relatively low-cost construction materials. The economic pressures were higher before 2010 due to issues with the world economy and changes in the global use of forest-based raw-materials. In the last years, there hasn't been similar pressures. In addition, the competing materials seem still to have had relatively low cost for the generated emissions and use of resources. This is one of the reasons, why wood construction is having performance issues compared to other materials and is not able to compete in the same price range. In a way, this is also the driver for innovation in wood construction. The competition has also caused wood construction to start building stronger networks across the whole value-chain. It seems likely, that wood construction will be favoured in the future governmental policies in Finland due to the ability to store CO_2, while also supporting strategy for the bioeconomy framework. Wood construction seems to have relatively wide legitimacy, even among the environmental NGO's. In the last years, construction levels have been high, and for the next years the amount of new construction is

expected to decrease. Wood construction seems to have missed this opportunity during the on-going decade. However, wood construction is looking ahead for new opportunities in renovations and taller buildings (referring here to taller than traditional wood construction).

Considering the table 4 above, the niche level has experienced changes as well. It seems, that before 2010, the new ideas and innovations were not aligned. This means that there was not a common system for implementation. Or in other words, the innovations supported competing ideas. In addition, there were not enough market ready niche-level products which could promote wide adoption of new system. However, the demands for taller constructions and constant competition with lower-cost materials seem to have aligned the niches. Coupled with the increasing networking across the value chain and pilot projects, the niche level seems almost ready to bring new systems into the market when window of opportunity opens. However, with the current technologies, the niche-level product adaptation in large scale requires competence building in the industry.

In the wood construction context, the bottleneck in performance seems to have shifted from having suitable products to lack of capabilities in implementing the solutions, as presented below in table 5.

Table 5. The qualitative matrix for industry level representing changes in wood construction found in this thesis

MLP	< 2010	> 2010
Industry	**Mission:** Build houses, look for new identities and holistic approach for increasing wood construction	**Mission:** System provider and integrator, search for new sustainable identity
	Capabilities: Product producing not in scale necessary for wide adoption, capability for small projects	**Capabilities:** Product producing in high level, construction efficiency requires more knowledge and trained professionals
	Technology: Products for small scale construction, large scale technologies in development	**Technology:** Tall buildings and new construction efficiency related products emerging to market
	Performance: Performance low compared to competitive materials, suitable products for efficient scaling as bottleneck	**Performance:** Performance not in the level of competitive materials, capabilities as bottleneck
	Networks: Network in the value chain	**Networks:** Network has been formed around bioeconomy
	Innovation: Niche product development, value chain innovation efforts together	**Innovation:** Moving from product innovation to understanding end-user preferences

MLP allows to estimate the transition pathways which the industry has experienced. Based on the qualitative matrix for wood construction as presented in table 5, mainly reproduction processes were dominating before 2010. With these reproduction processes, the industry was able to sustain the existing development trajectories. However, high niched development and innovation activity was present before 2010. This could be due to the environmental and economic pressures from the landscape-level which were acting as drivers. The economic pressures included competition with other materials. The existing construction system is built around other materials than wood. Bottleneck for wood adaptation in the beginning of

the millennium was the ability to produce products suitable for construction system. Moving to 2010's, the industry seems to have moved into a transformation pathway. The actors have survived the transition, but the industry is trying to reinvent itself and adopt new product innovations. It seems that the wood construction industry is moving towards holistic system deliveries and that values are created more from networks. However, there seems to be differences across the value-chain on how deep the transformation has been. Other companies have adopted new culture, core values, in these companies, mission and vision have changed. At the same time, considering wood construction, it seems that these deeper meanings for the industry are currently searched or forming. In addition, the innovation activities are moving towards end-user innovation, where previously technological innovations were in focus. The new bottleneck for wood construction is found from competences, the niche-innovations are emerging to markets, but adopting these still requires new capabilities which are not found in the industry at a large scale. One evidence of the transformation is also the increase of networks and co-operation efforts, it seems that the industry shape has changed during the last 20-years. The linear model of producing technologies to field has turned into a more complex network aiming to promote wood construction benefits and provide solutions.

Wood construction could also be considered as a niche level for the whole construction industry. Going forward to the 2020's climate change and resource competition pressures seem to increase, and this could cause higher social pressures. This could become in the form of new policies putting cost for waste and CO_2, while considering the whole life-cycle of materials. Considering tall buildings and large constructions, this could cause technological substitution and increase use of wood in construction. This would requiree that wood construction capabilities are in the necessary level when going to 2020's.

4.4.2 Wood construction TEF

The wood construction value-chain is analysed with the created qualitative matrix based on triple embeddedness framework. For understanding the possible differences along the value-chain, the industry is divided into three sections. In the wood construction value chain, upstream is formed by the logging, transportation and saw mills. The middle of the stream

is where the raw material is refined into products. In addition, the services such as design and engineering belong into the mid-stream. The actual construction sites, with the project management and construction companies, form the downstream. Each distinguished section in the value chain has their own supplier and customer base, whereas the policymaking and civil society environments are considered common along the value chain. The upstream suppliers are the forest owners and downstream customers are the end-customers selling and using the houses. The value-chain sections are presented below in figure 9. In figure 9, the value-chain is presented as embedded into the socio-political environment, whereas the economic environment is formed in the value-chain with supplier and customer relationships.

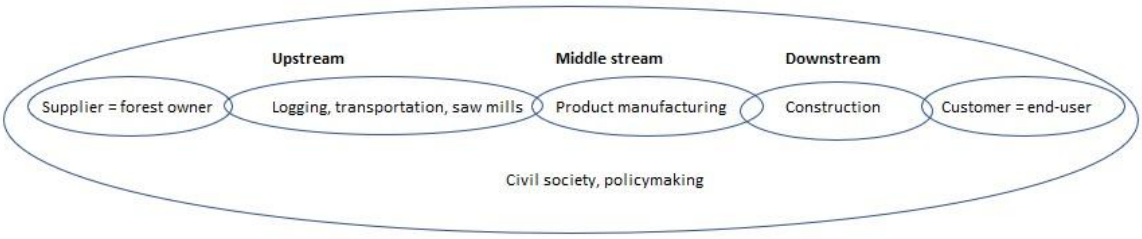

Figure 9. Division of wood construction value-chain into sections for TEF analysis

After the value-chain is described in the figure 8, it is possible to collect the data into the analysis matrix created for the study. The data collected for wood construction industry is presented below in table 6.

Table 6. Collected observations for wood construction value-chain

		Pressures from external environments			
	Reorientation stage	Economic environment		Socio-political environment	
Value chain	Estimated direction	Supplier	Customer	Policymakers	Civil society
Upstream (from forest and out from sawmill)	3 -> 4	**Forest owners** **Social:** Recreational values, aging ownership **Environmental:** Forest management, **Economic:** Sliced ownership of resources, price	**Product manufacturing** **Social:** PEFC requirements, drive for stronger networks, stability **Environmental:** product declarations, Life-cycle thinking **Economic:** Competitive price,	**Social:** Finnish bioeconomy, employment targets 100 000 new jobs, security, recreational values **Environmental:** Benefits compared to other materials under discussion, Biodiversity, sustainable amount of logging (forest growth), carbon sinks, preservation programs **Economic:** Bioeconomy strategy, recognizing saw mill economic difficulties, Ensuring availability of materials, low price of life-cycle CO2 emissions lowers pressures, export targets	**Social:** Resource management, quality of living, urbanisation, aging population, PEFC and FCS requirements, recreational values **Environmental:** Biodiversity, sustainable amount of logging (forest growth), carbon sinks, Climate change and biodiversity concerns , preservation **Economic:** Good price from wood to owners, employment,
Middle (Product and system manufacturing , design, engineerging)	2 -> 3	**Saw mills** Social: Employment in saw mills Environmental: Use roundwood in construction Economic: Roundwood price too high	**Construction** Social: Wood certification, networks Environmental: Wood certification Economic: Efficiency improvement, growth objectives, product standards		
Downstream (Construction, project management)	2 -> 3	**Product manufacturing** Social: Change to sustainable construction Environmental: Promote wood benefits compared to other materials, Bioeconomy related Economic: Competition with other materials (concrete), standardisation, construction capabilities should be	**End-customer** Social: Quality of living Environmental: Climate change awareness increasing, sustainability Economic: construction risks need to minimized, need to compete in price with other materials		

In table 6, it is estimated based on the data, that the upstream of wood construction industry is in a deeper re-orientation stage, where changes to the mission and vision is taking place. This is a generalisation, it could be seen that some large forest companies have already gone through re-orientation stage 4. However, the saw mills which belong in this analysis to the upstream section of the value chain, are going through turbulent times. This is due to economic difficulties, which in turn leads to higher pressures to re-orientation.

The middle stream on the other hand, has been focused for the past years in incremental innovation and standardisation. The pressures for the mid-stream product manufacturing to continue improving product standardisation continues, but at the same time the lack of capabilities, economic pressures and growth expectations create pressures for strategic re-orientation. Similarly, the downstream construction is estimated in this thesis to look for strategic re-orientation, facilitated by development of new capabilities and technologies. At

the same time, end-user role in the value-chain remains modest. The inference made here is that, social innovations would be most useful for the industry in the downstream near the end-user, but the re-orientation is in deeper stages in the upstream. The question then is, if the current mission and vision of the mid- and down-stream industry is capable to innovate solutions that meet the expectations of the end-user and which are useful for the society. Perhaps, social entrepreneurship could drive change in the downstream industry, which would then enhance the role of end-customer and benefits to society, which would lead to wider legitimacy of the wood construction industry. The pressures from policymaking remain modest and lean towards economic and environmental issues. The civil society, represented in this thesis by different NGO's, has some shared interests in the economic and environmental issues, but the benefits of wood construction to the society at large seem to be unclear, or at least not discussed that much. Therefore, it seems that the upstream transformation is at a deeper stage, but role of social innovations remains low. This could be self-explanatory, since the upstream serves the needs of their industrial customers. In the mid-stream, there are high economic pressures, which could lead to strategic re-orientation. In the upstream, there are pressures for growing the industry and amount of wood construction, especially in taller buildings. Economic and environmental drivers seem to have polarized the external environments, which makes it unclear if the current strategy is working for the industry. The industry is looking to build capabilities and is searching strategical options. Is it possible that social innovations could enhance the possibilities of growing amount of wood construction? Based on the data collected, it seems that there is little discussion on the social benefits of wood construction. In addition, the end-customer is not in the focus of the current projects. One inference could be, that the industry should build higher social capital and build horizontal co-operation with shared norms. This would mean creating shared mission and vision throughout the value-chain. Shared norms could increase the ability to create social innovations where the social innovation is most valuable, i.e. downstream at the end-customer. Re-orientation of the upstream may assist the industry in the short term, but re-orientation of the downstream seems to define how the industry will survive against competing systems.

4.4.3 Packaging board MLP

For the packaging board industry, the landscape pressures and development of niche innovations are presented below in table 7.

Table 7. Qualitative matrix representing landscape pressures and niche level developments in the packaging board context

MLP	< 2010	> 2010
Landscape pressures	**Social:** moderate **Environmental:** moderate **Economic:** High	**Social:** moderate **Environmental:** moderate **Economic:** moderate
Niches	Niche innovation development increases in economic pressure, search for alignment	Niches aligning around renewable material, circular economy, on-the move, smart, online sales

For packing industry, and specifically for packaging board, the landscape pressures have not caused severe pressures. The landscape on the packing industry has still changed during the past 20 years for efficiency, packaging sustainability, packaging durability and harmonization of materials. However, economic pressures were more dominant before 2010 compared to contemporary situation, these included decreasing demand of paper and issues in the world economy. Environmental pressures, such as climate change mitigation and promotion renewable materials, are creating favourable environment for the industry. This continues to be the case and this analysis leaves room for increasing pressures in the environmental dimension. In the social dimension, especially for food packaging, health and food safety trends seem to continue and grow, but due to complex perceived value of consumer packaging and continuous success of other materials, this analysis leaves room for increasing pressures in the social dimension as well from the landscape. In the social dimension, urbanisation, on-the-go culture and growing on-line deliveries all work in favour of the industry. As described in table 7, the industry was working with different niche

innovations, mainly focused on replacing other materials, already before 2010. Currently, these product innovations are actively entering the market, fully renewable package materials covering all relevant standards for safety and sustainability are introduced. These innovations seem to reply the urban demands of on-the-go culture. Though smart packaging innovations are not as ready as fully renewable packaging, they are included in figure 16 as it was observed as one of main trends in packaging innovations.

The previously mentioned economic pressures also started transformation processes, which worked out in favour of packaging board solutions and development of new product innovations. The regime changes include also new legislation, for example, the producer responsibility. Existing players survived, but new networks were formed which supported development of new wood-based products. The new industry was born with variations, since the niches were not ready to market before 2010. The transition of the industry level is presented below in table 8.

Table 8. The qualitative matrix for industry level representing changes in packaging board found in this thesis

MLP	< 2010	> 2010
Industry	**Mission:** Serve customers with quality products	**Mission:** Bioeconomy, renewable, innovative,
	Capabilities: Long tradition of capabilities, development of new in research	**Capabilities:** New capabilities for biorefinery concept developed, niche products coming to market
	Technology: efficiency, technology oriented, environment in process context	**Technology:** Market ready niches focus on differentiation in environmental dimension: renewable materials, recycling, circular economy,
	Performance: Performance issues	**Performance:** Good
	Networks: Trust between client and seller, joint development with customer	**Networks:** Increasing value from networks
	Innovation: Technological Innovation, environmental innovation	**Innovation:** Technological innovation, environmental, holistic thinking increasing, more power in downstream

After 2010, the industry has shown ability to reconfiguration, new innovations have been adopted to the existing system as solutions. These are involved around renewable materials, efficiency and circular economy. However, the process is ongoing as the pressures seem to increase further from landscape and more niche innovations are market ready. The success of the industry in reconfiguration could determine how the existing system will prosper if sustainability and renewable materials gain a more advantageous position in the market due to landscape pressures. If reconfiguration process is not successful, the question is whether technological substitution by niches will take place if large landscape pressures should be present after 2020. In the case of technological substitution, there could be a disruptive

element, when the players betting on non-renewable system would start to lose the market share to new niche innovations from renewable materials. This would open window of opportunity for new players, since investment flows could favour these new players. This could be the case, since competition with the niches could require technology and competences which require rapid investments. This could be beyond reasonable economic possibilities for the existing industry which has sunk investments in the balance sheet. The new players could be smaller players which together form a large industry, this could mean adding innovative value to the packaging at some point of the process before the packaging is in use and thus, replacing existing steps. These values could be generated by design, or by technologies such as smartness, but they could also be involved around how the packaging is distributed to use or on the actual event of packing the product.

It is possible to understand direction of the changes by looking the transition along different industry dimensions. As presented in table 8, the mission of the industry has gone through changes. It was noted however, that these new identities are mostly adopted by the large players operating more in the upstream business. This means, that the companies operating strictly in bioeconomy have adopted similar mission, but the industry includes many players who have different raw-material bases. The later are not as committed to the mission, but they were also not affected by the transformation which the packaging board industry experienced. The industry has developed new capabilities and product innovations, but at the same time are challenged by active niche level and start-up community. The new networks which have been formed around bioeconomy, seems to create more possibilities for piloting, thus leading to faster commercialisation. New products are now emerging to markets, but in the context of their respective industries, these solutions are still niches. It seems that when the innovation has one the race from other bioeconomy product, it enters a new competition in the downstream with new materials. This slows down adoption of the technology, since there will be a new valuation process which determines the innovations place in the market. The performance of the companies seems to be good currently, which allows investments in development and innovation. This good performance seems to be the result of successful transformation from the upstream companies. The changing environment was interpreted correctly and instead of small adjustments, the companies reinvented themselves. In the packing industry, the downstream is gaining more power. This is due to

centralization of retail business to only a few large players. These large players have also their own brands, which create a large share of the total sales. Therefore, smaller brand owners will need to adopt the packaging solutions that are acceptable for the dominating retailers. On the other hand, retailers are experiencing more customers using their purchasing power in a selective way, which drives the system towards customer centric thinking. This opens opportunity for social innovations in the packing industry, as maximizing value to customers and society could become a differentiating factor. However, for packaging board the challenge is, that the provided material should fit into these social innovations better that competing materials. However, the current situation is that the retail business is operating with many different materials. As was discussed before, technological substitution is a possible scenario if the downstream business misinterprets the pressures or doesn't succeed in strategical choices. In this case, it could be some other company such as Amazon, who creates the social innovation and adopts the renewable technologies to implement it. However, this thesis didn't find proof of technological substitution, due to the ongoing active networking and innovation, it is assumed that packing industry continues along reconfiguration.

4.4.4 Packaging board TEF

The packaging board value chain is presented below in figure 10, as simplified for this thesis. The upstream is formed from players in the bioeconomy and downstream contains companies which use multiple sources of raw-materials.

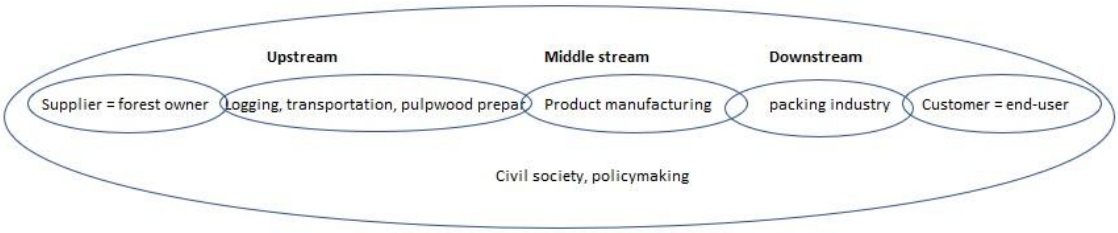

Figure 10. Division of packaging board value-chain into sections for TEF analysis

TEF analysis was done the same way as for the wood construction industry. Collected observations representing pressures from the external environments and estimated direction of the reorientation stage is presented below in table 9.

Table 9. Collected observations for packaging value-chain

		Pressures from external environments			
	Reorientation stage	Economic environment		Socio-political environment	
Value chain	Estimated direction	Supplier	Customer	Policymakers	Civil society
Upstream (from forest and out from sawmill)	3 -> 4	**Forest owners** **Social:** Recreational values, aging ownership **Environmental:** Forest management **Economic:** Sliced ownership of resources,	**Packaging manufacturing** **Social:** PEFC, FCS, **Environmental:** PEFC, FCS, production emissions **Economic:** Packaging material low cost	**Social:** Finnish bioeconomy, employment targets 100 000 new jobs, security, recreational values **Environmental:** Recycling targets, Biodiversity, sustainable amount of logging (forest growth), carbon sinks, preservation programs, producer responsibility **Economic:** Bioeconomy strategy, promoting wood based product export	**Social:** producer responsibility, safety, on-the-go, health **Environmental:** production more important than packaging in foods, protect forests, cc mitigation arguments are not understood the same way by different stakeholders, sustainability as holistic life cycle thinking, raw material sustainability and responsibility **Economic:** Packaging needs to remain low cost, increasing use of packaging (on-line orders, on-the-go)
Middle (Packaging manufacturing, design, engineerging)	2 -> 3	**Raw material supply** **Social:** Local, employment, responsible **Environmental:** Climate change mitigation, replace non-renewables **Economic:**	**Packaging industry** **Social:** Fit-for-purpose **Environmental:** Content protection main task, recyclable **Economic:** Minimizing packaging cost		
Downstream (Packing industry, brand owners)	2 -> 3	**Packaging manufacturing** **Social:** Replace non-renewable materials, sustainable solutions should be favoured **Environmental:** Recyclable and renewable, use of wood **Economic:** Support and services for cost efficiency	**Retail and End-customer** **Social:** Safety, design, technology, on-the-go **Environmental:** life cycle thinking increasing, disposal **Economic:** Complexity in perceived value, purchasing power, growing power of retail brands		

It could be observed, that the innovation trends have changed in the packaging board industry towards creating fully renewable products which serve the urban society. In the downstream, the retail and brand owner business is driven towards maximizing attention and customer value. It seems, that environmental drivers are important in the upstream bioeconomy 'world' where the packaging board are created and in the downstream where multiple materials are available the drivers are increasingly social. Environmental drivers in this case mean that the packaging board industry is utilizing the opportunities of renewable and bio-degradable material, which supports minimizing harmful waste. In addition, packaging board is relating itself in the climate change mitigation targets. The downstream business, in this case the retail and brand owners, are attempting to understand better the customer and provide products and services which are preferable for the customer. Since the customer behaviour is changing, the retail and brand owners are continuously more active in searching new solutions. In addition, on-line purchases, on-the-go urban culture require new approach and new distribution channels such as Amazon are looking to challenge also the retail

business in Finland. It should be noted, that these changes in customer behaviour, new urban cultures and even the reason why Amazon creates threats are social issues. This requires social innovation in understanding how value is created to the society which is changing. In the packaging board industry this seems to be understood fairly well, but the engineering talent and product development mentality seems to still continue relatively strong. This means that the packaging board industry should find a way to create networks with the downstream retail and packing industry. Maximizing value to society could be a possible common ground for the value chain, implying that social innovations could be the platform which allows shared mission and adoption of the best technologies for the best ideas. It seems that customer expectations are moving towards sustainability, which would make it reasonable for the downstream industry to look for social innovations together with renewable packaging producers.

5 DISCUSSION

Two different frameworks were used for analysing the case industries, MLP and TEF. It seemed that MLP was suitable for explaining changes in temporal direction. The TEF analysis allowed spatial observations across the value chain. MLP was used to identify how the industries have evolved during the past 20 years and what are the drivers behind the changes. TEF analysis allowed to look at the whole network, to understand better the actions in by the industry and role of external pressures in the transformation. In addition, splitting the value chain in three parts allowed interesting observations on the differences from upstream to downstream. Together these two analyses formed a picture, which can be looked to find clues for creating understanding on the role of social innovations.

This thesis estimated that the upstream raw material supply, which is the same for both cases, has experienced a more profound transformation. This means, in the TEF context, changes in mission and beliefs. This observation deserves attention also in the context of social innovations. The observation implies that the industries don't currently have a shared mission, beliefs or identity. This could stand in the way of horizontal networks. Horizontal networks and social capital have been said to be useful for creating social innovations (Hyytinen 2005, p.18). Increasing value network thinking instead of value-chain thinking, could improve the role of social innovation. However, since the value-chain downstream re-orientation seems to be moving towards similar ideas with the upstream, this network thinking might increase in the future. If this is the case, the role of social innovations might increase when the social capital is built further in the network and common mission is formed.

The same inference could be made from a opposite direction, by thinking where the social innovations should occur. Especially, when thinking about product or service innovations with benefits towards the civil society or society at large. If the downstream industries mission and identity is not geared toward creating maximum value to the society, this could slow down social innovations. Essentially, the downstream is the interface between the industry and the society for product innovations.

In addition, third supporting idea is that the value-chains seem to be experiencing legitimization issues and all stakeholders do not agree with the communicated benefits. Is it possible that downstream re-orientation stage slows down the success of social innovations, even if these are generated in the upstream? Thinking about the product innovations in both observed cases, this seems as a reasonable inference. Therefore, it could be explicitly inferred, that the role of social innovations for the case industries is to create maximum value to society which legitimizes their existence. However, lack of shared mission, and especially inertia in the downstream, currently slows down transformation efforts. If the benefits to society from new technologies in wood construction and packaging board solutions should be accelerated, attention to the downstream industry re-orientation stage could be helpful. This could un-lock the door for new product entries to markets, when common mission is achieved and maximizing benefits to society is in focus. As the downstream industry doesn't share the same identity, it doesn't communicate the values to the market and downstream also supports existing development trajectories for competing ideas. The social value could be thought also as perceived value, which can change for same products over-time. For example, if the non-renewable products are not perceived as valuable as renewable, offering renewable products creates value to the society. The observed pressures from uncontrollable landscape in MLP context and the socio-political environment according to TEF, seems to imply that adopting ideas of the upstream could be beneficial for the industries in creating maximum value to society, which could also legitimize existence of the industry.

5.1 Validation

Three types of validity are considered for the qualitative case study, these include construct validity, internal validity and external validity. Construct validity is focused in the way in which the case study is constructed. The main way of building construct validity in this study is based on constructing a chain of evidence from the sources found during the study. This means that all the findings are linked into the evidence chain in a manner which should provide transparency. It would be preferred to build construct validity also by use of multiple sources of evidence. (Yin 2014, 45-49.)

Construct validity is achieved in this work by providing the source tables in the material chapter, downside for the chain of evidence is that all the observations are not separately listed with sources. In addition, no interviews were performed, interviews across the value chain could increase validity of results. More rigorous efforts could be taken in connecting observations to the sources. The chain of evidence is presented in a separate table, which still offers the reader the possibility to understand what kind and which sources are used in the analysis. No interviews are used in the case study, which can be considered a limiting factor for the construct validity.

However, perhaps the most important step in construct validity is the development and selection of the operational set of measures. For theory operationalization, a different chapter is provided which describes how the changes examined in this study are represented by different phenomena. This means describing the variables to be used and how these variables are measured. The aim is to represent the changes by phenomena which can be measured with the collected data. One example of this is, that the change in consumer habits is difficult to describe without any operational set of measures. Therefore, changes in the importance of sustainability for consumers could be example of operational measure, which can be estimated based on the data collected from publicly available statistical data and surveys.

In this study, the theory operationalization was partly successful, but more specific variables in social dimension would be useful. It seems that it would had been useful to narrow the work further. For example, the economic and environmental dimensions could had been observed in a broad sense and more specific variables could had been created for the social dimension. The selected analysis framework leaves room for discussion on what kind of inferences can be made. For future studies, analysis could be improved by removing the economic and environmental dimensions and replacing those with specific variables in the social dimension. This would be justified when social innovations are in focus.

The second type of validity considered is internal validity. Internal validity refers to the validity of the conclusions or inferences made on causal relationships (Yin 2014, 47). Considering this study, internal validity is important to consider when looking at the role of social innovations for some desirable outcome. In other words, is it justifiable to assume that

in the contemporary events social innovations could have causal relationship with desirable outcomes. Whenever such inferences are made, rival explanations should be considered, and it should be explained how the available evidence converges to this inference. (Yin 2014, 47-48).

The internal validity in this work is handled by leaving out the inferences for which any rival explanations were found from the sources. Rival explanations were searched throughout the work in an iterative manner.

5.2 Generalization

External validity is the third type of validity, it is related to the generalization of the findings. (Yin 2014, 48). Generalization of the findings is one of the objectives of this thesis. External validity is considered as the validity for generalization (Yin 2014, 48). In the context of this thesis, this means the ability to generalize the findings from the case study for the wider forest-based bioeconomy framework.

For achieving certain level of generalization, the research questions made in a “what” format, should be expanded with “how” or “why” questions. Since the described research questions guide to a survey type study, adding “how” or “why” questions adds descriptive or explanatory nature for the case study. (Yin 2014, 48).

The selection of two value chains instead of one, creates a dual nature for the findings for the role of social innovations. Therefore, the comparison of the two cases allows to look for replicated results which could imply further ability to generalize the results. Since both case industries are part of the bioeconomy concept, generalisations are estimated possible when observations from both cases can lead to same inferences. However, this study didn’t leaves generalization mainly as a future research topic, but it is possible that from the collected data observational reader may take ideas suitable for generalisation in the global context.

5.3 Reliability

The research methods are described such a way, that similar study could be repeated when necessary. Given that the sampling and operationalization is successful, similar results should be obtained if the study is repeated by different researcher. The aim is to describe the used procedures clearly and document the case study systematically. (Yin 2014, 48-49).

In this study, the qualitative research is fairly simple since the qualitative matrices were created for collecting observation. However, there is room to improve further the collection matrices created in this thesis. It would be possible to increase the quality of the analysis, by focusing only in the social dimension. This could give the researcher possibility to operationalize more accurately in the social dimension, in this thesis the selected operationalization leaves room for discussion.

5.4 Qualitative study assumptions and limitations

The qualitative study in this thesis is focused on answering the research questions with a set of qualitative indicators, or operational measures, which values are derived from the collected evidence.

The case study could be expanded into multiple dimensions. However, the complexity of the analysis increases rapidly when level of detail or dimensions are increased. Therefore, several assumptions and simplifications are necessary for achieving suitable scope for this thesis.

One of the assumptions in this thesis is, that social innovations provide financial profitability for businesses. Therefore, this thesis takes for granted that it is meaningful to study the role of social innovations in the business context.

No interviews were performed, which can be considered as a limitation for the trustworthiness of the results and further research with interviews of different players in case industries could increase the understanding on the role of social innovations. These

interviews could include company CXO's along the value chains, consumer groups and different change agents in the field.

In addition, research on the transition of the social representations could be done by case study on how the subjects have been represented in media and public discussions in different development stages. Social representation investigation could provide backbone to understand how the legitimization efforts have been transferred to the target groups and what role do social innovations have in the formation of mental images.

5.5 Future research topics

In future studies, it could be interesting to understand better what kind of mental images and shared cognitive meanings bioeconomy has in the society. In addition, if the mental images do not support legitimization of the bioeconomy, is there differencies in how the upstream and downstream industries are taking part in the discussion which forms these views. Essentially, is the downstream industry communicating benefits of the bioeconomy similarily to upstream and how does this affect legitimization of the industry? If there indeed are mixed messages delivered from the same industry, this could be one reason why economic and environmental dimensions are not succeeding in legitimization.

If wood construction builds tighter collaboratios, it could be possible to include other sectors into the ecosystem as well. This could be useful, especially considering competition in the global markets. One possibility would be to brand Finnish wood construction together with the developing smart city technologies. Wood construction association together with IoT infrastructure and smart city future could bring synergies and social legitimacy for both wood construction and new ICT-solutions. This would mean that while social dimensions of wood would be emphasized by design, also high level of smartness would be embedded in Finnish wood construction solutions. This could offer opportunities to export holistic solutions as healthy and smart living community district from Finland. This would increase the export value for the construction elements, if the modern ICT-solutions would be embedded in the wood construction. The possibilities should be further studied, but examples could include embedded smart sensor technologies, data transfer and

contextualization, interfaces, energy production and storage, as well as architectural solutions supporting active living for the area. This could mean, for example, that the buildings manufactured readily produce and store energy while exchanging information between apartments and other buildings for energy production and consuming, helping the prosumer resident with market ready solution. Or the building could include sharing economy solutions with embedded solutions for car sharing or similar commodity. With data contextualization the buildings could readily understand something from the behavioural habits of the residents and offer solutions or make adaptations when new residents move in. Why not also measure the resident well-being and utilize this information in design of new buildings as well as communicating best results to other buildings for improvements. Also, the building administrative tasks could be implemented in the same platform. For example, building could add to the board meeting agenda automatically suggestions, like accepting update in inspection routine when other building learned certain items need to be checked more frequently. The same way, increasing use of bicycle or different health applications could be included. These are all only ideas rising from the observations on the differences in identities along the value chain and possibilities of horizontal integration. The key would be to find what are the social benefits of wood construction and emphasize those with design, architecture and degree of smartness. For increasing innovation activities, open innovation platforms could be also useful for wood construction industry, since consumer behavioural changes might be better taken into account by including variety of stakeholders. These collaborations could open new doors, when the industry is looking for the identity of Finnish wood construction when going to the 2020's. In a similar manner, for the packing industry this could mean a smart factory, which packs the product into the fully renewable smart packaging and operates in the biorefinery concept optimized for location and efficient utilization of all streams. After this, the product distribution might take place in a innovative way which adds value to the process and serves the product in the right place in the right time, thus minimizing waste.

6 CONCLUSIONS

In the case studies, MLP seemed suitable at explaining what kind of transition the industries had experienced. However, the division of the value chain in three parts of the TEF seemed to reveal that the pressures were not evenly distributed across the value chains. The packaging board industry re-orientation seems to be further across the whole value chain due to the pressures in earlier years affecting the whole value chain.

RQ 1.1 What kind of theoretical and conceptual framework is needed for sustainable transition considering the value chains of packaging and wood construction?

It was found that it is useful to understand the value chains in MLP context, with a changing landscape that the industry has little influence on, this allows to understand what kind of pressures need adoption. TEF framework and especially the division of the value chain into sector proved useful in assessing the pressures from external environments, but also for estimating the internal pressures of the value chain. This could provide ideas on how to better build the horizontal collaboration inside the value chain, when it is understood what kind of drivers each have and what kind of pressures they are facing. In addition, this could allow to understand what kind of actions can be taken in horizontal collaboration if strategic actions are needed towards external environments.

For example, the wood construction industry could follow the example from packaging board value-chain developments. Since the pressures from the socio-political environment could continue to increase, the shared norm across the value-chain could allow utilizing the new market ready niches in co-operation with the excisting and new players. For example, as packaging board is developed in the biorefinery concept, new smaller players are joining the ecosystem. In the wood construction industry, similar horizontal approach in co-operation could help the industry to use both the knowledge from established companies and transformational power of the niche innovations from new start-ups. This seems to be already recognized in both industries, which have started such network iniatives as pakkauslaakso (2018) for packing industry.

RQ 1.2 What kind of innovation paths have the wood construction and packaging board value chains followed during the past 20 years?

In both cases, technological innovation and environmental innovation have been important in the 2000's. The upstream business has gone through a deeper re-orientation in mission and vision, which can be seen in a search for new meanings and visions for creating sustainable products and services. The downstream businesses are continuing to optimize between different materials, but seem to be moving in the same direction with the upstream. The networking activities have continued to increase. As horizontal collaboration was found important for social innovations, it is possible that new ambitions are currently rising in the social dimension for benefits leaning towards society.

Currently, the wood construction industry pressures are increasing in different parts of the value chain, and taking on the challenges in network collaboration could be important factor in success of the excisting companies. This would mean reconfiguration process, as it is named in the TEF. The other option could be, that players develop their offering in a closed interaction with excisting partners and niche innovations are developed in a seperate niche community. This could lead to slower market penetration for the new innovations, which means growing pressures from external environments and could lead to technological subsititution. Technological substitution in this case, could mean turbulence in the markets. The scenario would be that new players begin receiving increased funding for new products and challenge the excisting system. Since the new players might not have the same capabilities and existing collaborations as the excisting industry, it would be reasonable to assume some level of issues in the beginning. Also there could be higher percentages of companies failing for some time in the new system, as the new players compete for market dominance. It is difficult to predict which scenario has higher propability.

RQ 1.3 What kind of economic, environmental and social drivers can be found behind the innovation trends?

The economic drivers were not extensively studied. However, it was found that strong economic pressures have been present, which seem to have been effective in driving the industries into deeper re-orientation stages and changes in mission and vision. Environmental drivers are in the upstream business oriented towards responsibility actions, but the new mission and vision of the upstream businesses are built around environmental factors. The social drivers are in the upstream mainly toward social sustainability. Going to downstream the environmental dimension moves towards creating products which the customer can approve. It seems that more networking efforts are taking place, which could drive towards higher appreciation of social innovations due to horizontal collaborations and knowledge transfer. From social drivers, the strongest could be change of consumer behaviour towards holistic sustainability thinking, which could be the factor driving downstream business to think what kind of products and services are beneficial for the society.

Based on the MLP and TEF analysis, it could be concluded that the dominant future development scenario depends on the ability of the industry to re-orient for shared vision, collaborate in horizontal networks for reconfiguration process, and finally on the velocity and magnitude of landscape pressures. In addition, this thesis only looked at Finnish markets, in a global setting, the companies need to address also the developments in global competition. If large and sudden pressures develop, technological substitution could be the case. If instead, pressures develop slowly, the industry could have enough time to take the steps for reconfiguration. The packaging industry seems to be beating this race for reconfiguration, but there also the production processes are highly capital intensive and require similar capabilities compared to previous technologies. In the case of wood construction, the needed capabilities seem to differ more also in the short term. Therefore, the wood construction industry should propably increase its race pace if reconfiguration would be preferred.

If the industries in the bioeconomy do not have shared identity as was concluded in this thesis, is it possible that this has caused polarized views on the bioeconomy in the society? Vice versa, if the industries would share common identity which is formed around maximizing benefits to society, would there be wider acceptance of bioeconomy. This thesis concludes that this seems to be the case and specifically the re-orientation of the downstream beliefs seems to slow down adoption of the technologies. Since external pressures caused the upstream to look for new identity, it is possible that changes in customer behaviour creates pressures for the downstream to provide more benefits to the society? When looking at these kind of pressures from external environments, industries have to make strategical choises in what they believe will create desirable outcomes. This thesis was looking specifically the cases in Finland, and if the industries in Finland are looking for differentiation and success in global markets, proactive measures could create first-mover advantages. Surely, observations supported the fact that this process is currently in place, though packing industry seems to move faster and product innovations are brought to market which are driven by creating sustainable society. However, the downstream industries may select between plethora of materials. Essentially, to speed up the bioeconomy adoption, even before tremendous pressures force new identity, creating values to the society, which would not otherwise occur, can create completely new market segments. Horizontal co-operation is necessary for the success of products created up- and midstream for creating shared social capital with the downstream. This way the downstream industry may adopt the mission and identity from the upstream and add to it with the knowledge from contemporary changes in the socio-political environment, meaning essentially knowledge about what the end-user perceives as favourable to the society.

RQ 1: What is the role of social innovations in the Finnish forest based bioeconomy
Conclusion: The role of social innovation is related to the common vision and mission of the industry which enables creating products and services that have demand, create new market segments and support sustainable society.

Social innovations importance seems to increase moving towards the downstream business opportunities, since downstream acts as a gate to the end-customer. Currently, these ideas

are better appreciated in the upstream vision and mission. In addition, the differencies in the mission and identity along the studied value chains could slow down creation of the social innovations, which in turn might limit the industry transition and growth of market share. Therfore, industries should focus in creating shared mission and identity. Considering the packaging industry, the upstram production seems to be furher in it's reorientation towards solving global challenges and responding to changes in the market. However, when social drivers are increasing from upstream, they are not successful until the downstream industry shares the values. This could be seen in competition with other resources. When someone makes a great innovation, which would solve social issues resulting from bad waste management or food security, it might prove difficult if the downstream industry doesn't share the values.

REFERENCES

94/62/EC. European Parliament and Council directive, 20 December 1994 on packaging and packaging waste.

2016/C 075/06. A bioeconomy for Europe. European Parliament resolution of 2 July 2013 on innovating for sustainable growth: a bioeconomy for Europe (2012/2295(INI)).

Ahvenainen, M. Hietanen, O. Huhtanen, H. 2009. Tutu-ejulkaisuja 2/2009. Tulevaisuus paketissa. Tulevaisuuden tutkimuskeskus. Turun kauppakorkeakoulu. ISBN 9789515645593. [e-document]. From: https://www.utu.fi/fi/yksikot/ffrc/julkaisut/e-tutu/Documents/eTutu_2009-2.pdf

Alasuutari, Pertti. 2011. Laadullinen tutkimus 2.0. Vastapaino. (e-book). Ellibs. From: https://www.ellibslibrary.com/fi/book/978-951-768-385-2

Biotalous. 2018. Puurakentaminen. From: http://www.biotalous.fi/puurakentaminen/

Bosman, R., Rotmans, J. 2016. Transition governance for the bioeconomy: comparing Finland and the Netherlands. SusValueWasteseminar12th of January2016. From: http://www.susvaluewaste.no/wp-content/uploads/2016/01/Bosman_Seminar.pdf

EC. 2012. European Comission staff working document. Accompanying the document Communication on Innovating for Sustainable Growth: A Bioeconomy for Europe. From: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52012SC0011&qid=1490608720256

EC. 2018. European Comission web-pages: Horizon 2020 – Societal challenges. From: https://ec.europa.eu/programmes/horizon2020/en/h2020-section/societal-challenges

Eskola, J. Suoranta, J. 1998. Johdatus laadulliseen tutkimukseen. Osuuskunta vastapaino. Tampere. ISBN 978-951-768-504-7. [e-book]. From: https://www.ellibslibrary.com/book/978-951-768-035-6

FCS. 2018. FCS certification web pages. From: https://fi.fsc.org/fi-fi/sertifiointi

Geels, F. & Schot, J. 2007. Typology of sociotechnical transition pathways. Research Policy, 36(3), 399–417.

Geels, F. 2014. Reconceptualising the co-evolution of firms-in-industries and their environments: Developing an inter-disciplinary Triple Embeddedness Framework. Research Policy, 43, 261– 277

Greenpeace. 2018. Metsävetoomus. Greenpeace Finland web pages. From: https://metsat.greenpeace.fi/pages/metsavetoomus

Haltia, E. Rämö, A-K. Pynnönen, S. Valonen, M. Horne, P. 2017. PTT raportteja 255. Miksi metsien taloudellisia mahdollisuuksia jätetään käyttämättä? - Metsänomistajien aktiivisuus ja siihen vaikuttaminen. Pellervon taloustutkimus PTT. Helsinki. ISBN 978-952-224-194-8. [e-document]. From: http://www.ptt.fi/media/img/nostot/ptt-raportteja-255.pdf

Heräjärvi, H. Kettunen, L. Murtovaara, I. 2014. Metlan työraportteja 284. Uudistuvat puutuotearvoketjut ja puunhankintaratkaisut (PUU). Tutkimus- ja kehittämisohjelman keskeiset tulokset. ISBN 978-951-40-2461-0. [e-document]. From: http://www.metla.fi/julkaisut/workingpapers/2014/mwp284.htm

Huuskonen, J. Palsanen, J. Sierilä, P. Levlin, J-E. Niemi, T. Sundquist, J. Wartiovaara, I. 2013. Tuote- ja teknologiainnovaatiot muuttivat rajusti suomalaista paperiteollisuutta 1900-luvun jälkipuoliskolla, yhteenveto innovaatioista sellu-, paperi- ja kartonkiteollisuudessa. Paperi-insinöörit ry. [e-document]. From: https://www.puunjalostusinsinoorit.fi/site/assets/files/1356/innovaatioiden_yhteenveto_2014_painoversio.pdf

Hyytinen, Kirsi. 2005. VTT. VTT-WORK-30. Sosiaalisten ja teknologisten innovaatioiden yhdistyminen ESR-hankkeissa - Tapaustutkimus. 951-38-6581-9. [e-document] From: https://www.vtt.fi/inf/pdf/workingpapers/2005/W30.pdf

Junka, Teuvo. 2010. Valtion taloudellinen tutkimuskeskus. Tutkimukset 155. Valtionyhtiöt 1975 – 2008. ISBN 978-951-561-912-9. [e-document]. From: http://www.doria.fi/bitstream/handle/10024/148691/t155.pdf?sequence=1

Karjalainen. 2017a. Rakennustaito. Professori Markku Karjalaisen haastattelu rakennusmääräyksistä. From: https://rakennustaito.fi/digilehti/022017/rakennusmaaraykset-3

Karjalainen. 2017b. Ympäristöministeriö. Tampereen teknillinen yliopisto. Professori Markku Karjalaisen suorittaman puukerrostalojen asukas- ja rakennuttajakyselyn loppuraportti. [e-document]. From: http://www.ym.fi/download/noname/%7BDE24E1B6-B79D-4498-B7DE-DE837EE89D88%7D/128751

Kiinteistölehti. 2017. Puurakentamisen odotetaan kaksinkertaistuvan lähivuosina. From: https://www.kiinteistolehti.fi/puurakentamisen-odotetaan-kaksinkertaistuvan-lahivuosina/

Koistinen, A. Käär, L. Mäki, O. Tenhola, T. 2015. Metsien rooli EU:n biotalouden kehityksessä. Tapion raportteja nro 2. Tapio Oy. ISBN 978-952-5632-22-4. [e-document]. From: https://tapio.fi/wp-content/uploads/2015/05/Metsien_rooli_EUn_biotaloudessa_Tapionraportteja21.pdf

Korkman, O., Greene, S. 2017. The changing relationship between people and goods. Sitra study. Helsinki. ISBN 978-951-563-996-7. [e-document]. From: https://media.sitra.fi/2017/05/05143553/Selvityksia122.pdf

Lehtonen, L. Uusitalo, O. 2011. Pakkauksen arvo kilpailuedun lähteenä. N:o 181. Jyväskylän yliopistonkauppakorkeakoulu. ISBN 978-951-39-4529-9. [e-document]. From: https://jyx.jyu.fi/bitstream/handle/123456789/36910/PAKKI_Screen.pdf?sequence=1

Loukasmäki, Pasi. 2016. TEM toimialaraportti 6/2016. Puutuoteollisuus. ISBN 978-952-327-156-2. [e-document]. From: http://julkaisut.valtioneuvosto.fi/handle/10024/79840

Luke. 2017. State of Finland's Forests 2012 Criterion 1 Forest resources: Building with wood. From: http://www.metla.fi/metinfo/sustainability/c1-building-with-wood.htm

Luke. 2018. Statistics. Use of wood by sectors. From: http://statdb.luke.fi/PXWeb/pxweb/fi/LUKE/LUKE__04%20Metsa__04%20Talous__08%20Metsateollisuuden%20puunkaytto/02_metsateol_puunk_toimialoittain.px/?rxid=dc711a9e-de6d-454b-82c2-74ff79a3a5e0

Matveinen, Mikko. 2014. Biotalouden innovaatioympäristöt – Puurakentaminen. Joensuu. Karelia-ammattikorkeakoulu. 38. C, raportteja 18. ISBN 978-952-275-132-4.

McCormick, K, Kautto, N. 2013. The Bioeconomy in Europe: An Overview. Sustainability, 5: 2589-2608. http://doi:10.3390/su5062589

Metsäkeskus. 2018. Metsäalan toimijat. From: https://www.metsakeskus.fi/metsaalan-toimijat

Metsäteollisuus. 2018. Katse vuoteen 2025. Uusiutuva metsäteollisuus, menestystä biotaloudesta. [e-document]. From: https://www.metsateollisuus.fi/mediabank/5242.pdf

MHY. 2018. Metsänomistajat. Metsänomistajat haluavat hoitaa metsiään itsenäisesti ja vastuullisesti. From: https://www.mhy.fi/uutiset/metsanomistajat-haluavat-hoitaa-metsiaan-itsenaisesti-ja-vastuullisesti

Mikkilä, M., Koistinen, K., Linnanen, L. Blurring sectoral boundaries: Agent driven system transition on the interphase of the forest based bioeconomy and energy sector. Symposium "Social Innovation and Energy Transition" Delft Energy Initiative, Delft, the Netherlands, April 3-4, 201.

MTK. 2018. Maa- ja metsätaloustuottajain Keskusliitto. Muu lainsäädäntö. Kestävän metsätalouden rahoituslaki (Kemera). From: https://www.mtk.fi/metsa/metsapolitiikka/Kotimaan_metsapolitiikka/fi_FI/muu_metsalainsaadanto/

Muilu-Mäkelä, R., Haavisto, M., Uusitalo, J. 2014. Metla. Working papers of the Finnish Forest Research Institute. Puumateriaalien terveysvaikutukset sisäkäytössä – kirjallisuuskatsaus. [e-document]. From: http://www.metla.fi/julkaisut/workingpapers/2014/mwp320.pdf

Niskanen, A. Donner-Amnell, J. Häyrynen, S. Peltola, T. 2008. Metsän uusi aika - kohti monipuolisempaa metsäalan elinkeinorakennetta. Joensuun yliopisto, Metsätieteellinen tiedekunta. ISBN 978-952-219-116-8. [e-document]. From: http://epublications.uef.fi/pub/URN_NBN_fi_joy-20080022/URN_NBN_fi_joy-20080022.pdf

Nykänen, E. 2017. Puurakentaminen Euroopassa, LeanWOOD. Häkkinen, T. Kiviniemi, M. Lahdenperä, P. Pulakka, S. Ruuska, A. Saari, M. Vares, S. Cronhjort, Y. Heikkinen, P. Tulamo, T. Tidwell, P. Espoo. Teknologian tutkimuskeskus VTT Oy. 132. VTT Technology 297. ISBN 978-951-38-8534-2. (e-document). From: https://www.vtt.fi/inf/pdf/technology/2017/T297.pdf

Oliver, C. D., Nedal T. Nassar, N. T., Lippke, B. R., James B. 2014. Carbon, fossil fuel, and biodiversity mitigation with wood and forests. Journal of Sustainable Forestry, 33:3, 248-275. Available at doi:10.1080/10549811.2013.839386

Pakkauslaakso. 2018. Packing industry ecosystem web pages. From: https://pakkauslaakso.fi/

PEFC. 2018. PEFC certification web pages. From: https://pefc.fi/

Phills Jr., J. A., Deiglmeier, K., Dale T. Miller, D. T. 2008. Rediscovering Social Innovation. Stanford Social Innovation Review. Fall. Available at: https://ssir.org/articles/entry/rediscovering_social_innovation

PTR. 2017. PTR report 63. The packaging value cycle: A framework for evaluating packaging investments. Package Testing & Research Ltd. ISBN 978-951-8988-50-5. From: https://ptr.fi/Raportit/PTR_63_PackagingValueCycle.pdf

Puuinfo. 2018a. Puurakenteiden paloturvallisuus. From: https://www.puuinfo.fi/puutieto/puusta-rakentaminen/puurakenteiden-paloturvallisuus

Puuinfo. 2018b. Puurakentamisen sosiaalinen ja kulttuurinen kestävyys. From: https://www.puuinfo.fi/node/1519

Rakennuslehti. 2017. Rakennuslehti web pages. Betoniteollisuus uskoo puukerrostalorakentamiseen. From: https://www.rakennuslehti.fi/2017/06/betoniteollisuus-uskoo-puukerrostalorakentamiseen/

SMY. 2018. Suomen metsäyhdistys web pages. From: https://smy.fi/metsayhdistys/
Solidium. 2018. Holdings. From: https://www.solidium.fi/en/holdings/holdings/

Stora Enso. 2018. http://buildingandliving.storaenso.com/News-Site/news/Pages/Stora-Ensos-sustainable-wooden-solutions-present-in-URBAN-FUTURE-Conference-in-Vienna.aspx

Säilä, A. 2018. Pääkirjoitus – Kaupan merkitys on kasvussa ja niin on myös pakkausten merkitys kaupalle. Pakkaus.com web pages. From: https://www.pakkaus.com/kaupan-merkitys-on-kasvussa-ja-niin-on-myos-pakkausten-merkitys-kaupalle/

Tainio, Risto. 2004. Suomen yrityssektorin rakenteellinen ja kulttuurinen muutos. Helsingin kauppakorkeakoulu. Sitran artikkelikokoelma tutkimushankkeesta sosiaaliset innovaatiot, yhteiskunnan uudistumiskyky ja taloudellinen menestys. Helsinki. ISBN 951-563-466-0. [e-document]. From: https://media.sitra.fi/2017/02/27172203/Heiskala-2.pdf

Toppinen, A., Röhr, A., Pätäri, S., Lähtinen, K., & Toivonen, R. 2018. The future of wooden multistory construction in the forest bioeconomy - A Delphi study from Finland and Sweden. Journal of Forest Economics, 31, 3-10. https://doi.org/10.1016/j.jfe.2017.05.001 From: http://www.woodenliving.net/tulokset.html

T&T. 2005. Äly asettuu pakettiin. Tekniikka ja talous web pages. From: https://www.tekniikkatalous.fi/tekniikka/ict/2005-09-01/%C3%84ly-asettuu-pakettiin-3270425.html

TEM. 2014. Biotalousstrategia 2014. Kestävää kasvua biotaloudesta, Suomen biotalousstrategia. [e-document]. Edita Publishing Oy. From: http://biotalous.fi/wp-content/uploads/2014/07/Julkaisu_Biotalous-web_080514.pdf

TEM. 2017. Wood-Based Bioeconomy Solving Global Challenges. ISBN 978-952-327-214-9. [e-document]. From: http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/79985/TEM_oppaat_2_2017_Wood_based_Bioeconomy_Solving_Global_challange_29052017web.pdf?sequence=1&isAllowed=y

Tilastokeskus. 2017. Statistics Finland. Waste statistics. From: http://tilastokeskus.fi/til/jate/tau.html

Tilastokeskus. 2018. Statistics Finland. Innovation. From: https://www.tilastokeskus.fi/til/inn/index.html

VNK. 2018. Valtioneuvoston kanslia. Omistusosuudet ja eduskuntavaltuudet omistuspohjan laajentamiseksi. Valtion omistusosuudet ja eduskuntavaltuudet 13.06.2018. From: http://vnk.fi/omistajaohjaus/eduskuntavaltuudet

WWF. 2017. Tutkimus: suomalaiset haluavat vähentää ruoan ympäristövaikutuksia – parhaat keinot eivät kuitenkaan ole selvillä. WWF web pages. From: https://wwf.fi/wwf-suomi/viestinta/uutiset-ja-tiedotteet/-Tutkimus--suomalaiset-haluavat-vahentaa-ruoan-ymparistovaikutuksia---parhaat-keinot-eivat-kuitenkaan-ole-selvilla-3091.a

Yin, R. K. 2014. Case Study Research, Design and Methods. 5th edition. United States of America, California. SAGE Publications, Inc. 282 p. ISBN 978-1-4522-4256-9.

Yle. 2018. Mikä vaivaa suomalaista miljardibisnestä? Syksyllä saatetaan nähdä sahojen pudotuspeli – "Meillä pitäisi mennä aivan erinomaisesti, mutta ei vain mene". Yle.fi internet pages. From: https://yle.fi/uutiset/3-10209240

YM. 2013. The Ministry of the Environment. Finland. Pakkausten tuottajavastuu. From: http://www.ymparisto.fi/fi-FI/Kulutus_ja_tuotanto/Jatteet_ja_jatehuolto/Tuottajavastuu/Pakkaukset

YM. 2018. The Ministry of the Environment. Finland. Waste statistics. From: http://www.ymparisto.fi/fi-FI/Kartat_ja_tilastot/Jatetilastot/Tuottajavastuun_tilastot/Pak-"kausjatetilastot