Jaakko Jussila

Transformation towards sustainability in the construction market

Adoption of wood construction in Finland

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Tiivistelmä

Ilmastonmuutos vaatii toimia kestävän kehityksen edistämiseksi maailmanlaajuisesti. Se edellyttää kansakuntia ja teollisuudenaloja muuttamaan totuttuja toimintatapojaan. Rakennusalalla on tärkeä rooli kestävän kehityksen murroksessa sen yhteiskunnallisen merkityksen ja intensiivisen raaka-aineiden käytön vuoksi. Tämän väitöskirjan tavoitteena on luoda parempi käsitys kestävän kehityksen siirtymää mahdollistavista tai estävistä tekijöistä rakennusalalla ja asuntomarkkinoilla. Puurakentaminen nähdään alalla yhtenä ratkaisuna hiilijalanjäljen pienentämiseen korvaten betonirakentamista. Empiirisessä tutkimuksessa kiinnostuksen kohteena on erityisesti kuntien ja instituutioiden rooli puun käyttöönoton tukemisessa Suomen rakennusalalla.

Muutosvaatimusten ymmärtämiseksi tämän tutkimuksen artikkelissa I tehdään synteesi tieteellisestä kirjallisuudesta liittyen puukerrostalorakentamisen kehitykseen vaikuttavista mahdollistavista ja hidastavista tekijöistä. Tutkimus käyttää asuntotarjonnan rakennetta kuvaavaa mallia (ns. SHP-konsepti), joka kattaa asuntojen tuotannon, vaihdannan ja käytön, tarkastellakseen kestävän kehityksen siirtymään vaikuttavia ajureita ja esteitä. Seuraavaksi artikkelissa II analysoidaan institutionaalisten käytäntöjen roolia asuntomarkkinoilla omakotirakentajien näkökulmasta, missä puun käytöllä on pitkät perinteet. Useiden instituutioiden, valtion toimien ja sääntelyn voidaan havaita vaikuttavan kestävän kehityksen siirtymään muuttaen toimintaympäristöä. Lopuksi artikkelissa III tutkitaan kuntien roolia kestävän kehityksen muutoksen edistämisessä ja puun käyttöönotossa rakentamisessa. Väitöskirja esittelee analyyttisen viitekehyksen, joka ohjaa tutkimusta ja auttaa jäsentelemään kestävän kehityksen siirtymään liittyvää laajaa ja monimutkaista ongelmaa rakennusalalla.

Rakennusalan kohdatessa kestävyysmurroksen, voidaan teollista puurakentamista edistävinä tekijöinä nähdä positiiviset tuoteominaisuudet sekä tuoteinnovaatiot, kuten esivalmistuksen kautta saavutettava rakentamisen tehokkuus. Toisaalta korkeammat kustannukset, tuotteen laatuun liittyvät ennakkoluulot, sekä epäsuotuisat institutionaaliset käytännöt hidastavat puurakentamisen kehitystä. Muutoksen aikaansaamiseksi puurakentamista on tarkasteltava laajemmin asuntomarkkinoiden kontekstissa, ei pelkästään asuntotuotantoon liittyvien teknologisten ja kustannustehokkuusnäkökulmien kautta.

Asiasanat: puurakentaminen, kestävä siirtymä, asuntotarjonnan rakenne.

Abstract

Climate change calls for actions towards sustainability on a global level. It requires nations and industries to transform the ways in which they are used to operating. The construction sector plays a vital role to expedite the transition towards sustainability due to its contribution to society and intense usage of raw material. This dissertation aims to create a better understanding of the factors that enable or hinder sustainability transition in the construction sector and housing markets. In the construction industry, wood construction is considered a solution for reducing the carbon footprint by replacing concrete construction. The role of municipalities and institutions in supporting the adoption of wood in the Finnish construction sector is a topic of specific interest for this empirical study.

First, to understand the requirements for sustainability transition, this research synthesises the current scientific literature for enabling and hindering factors affecting the development of the wooden multi-story construction sector in Article I. This study implements the concept of structures of housing provision (SHP) that comprise spheres of production, consumption and exchange of houses to approach drivers and barriers for sustainability transition. Next, the role of institutional practices in the housing market is analysed in Article II from the perspective of homebuilder families in the detached home market, where wood has traditionally been used for a long time. Several institutions and governmental actions and regulations are found to affect the sustainability transformation at the level of the socio-technical landscape. Finally, Article III investigates the role of municipalities in enabling the sustainability transformation and adoption of wood in the construction sector. This dissertation presents an analytical framework that guides research and helps identify the broad and complex problems of the sustainability transition in the construction sector.

As the construction sector gradually transforms towards sustainability, the benefits of the sustainability of wood and product innovations, such as efficiencies through pre-fabrication, facilitate industrial wood construction. In contrast, higher cost concerns, prejudices on quality and unfavourable institutional practices hinder the use of wood. To transform the construction industry, wood construction must be viewed not only in terms of supply mechanisms mainly connected with technological and perceived cost-efficiency benefits but also in the context of housing markets.

Keywords: wood construction, sustainability transition, structures of housing provision.

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My journey as a PhD student has not always been as straightforward or optimal as one may generally think; however, I believe I needed all the confusing obstacles, side roads and barriers I experienced to transform the dissertation to its present form. Most of the time, conducting research and writing a dissertation has been a lone man's work, which required countless hours of sitting alone in an empty office with my laptop and patience to overcome many struggles and puzzles along the way. As I look back, I realise that all the exciting bypaths were needed to help me learn the required lessons during the path, build the research stronger, and enjoy many scenes along the way. Luckily, I did not have to travel alone all the way. This dissertation would not have been accomplished without the support, guidance, sparring and criticism of academic colleagues, supervisors, co-authors, examiners, reviewers, opponents and my family and friends.

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Jaakko Jussila

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Abbreviations

CLT	Cross-laminated timber
ECB	European Central Bank
GDP	Gross domestic product
GDPR	General Data Protection Regulation
MLP	Multi-level perspective
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SDG	Sustainable development goals
SHP	Structures of housing provision
WMC	Wooden multi-story construction

Publications

Article I:

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Article III:

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1 INTRODUCTION

Climate change, as the most pressing global issue humanity is facing right now, calls for sustainability transformation in the emission-intensive construction sector in terms of the adoption of low-carbon solutions. Since wood is a renewable material with carbon storage properties, timber structures have beneficial climate impacts compared to other construction materials (Geng et al., 2017; Hafner & Schäfer, 2017; Hildebrand et al., 2017; Peñaloza et al., 2016). Construction and housing play a fundamental role in aiming at societal goals for sustainable development (Toppinen et al., 2018) and in providing business opportunities to companies involved in the forest industry. Sustainability transformation is systemic, meaning that it affects all entities and different actors need to collaborate to achieve the desired transformation. The effectiveness of tackling this global challenge depends on the construction industry and involved actors, along with their receptivity to change. This dissertation aims at creating a better understanding of factors enabling or hindering sustainability transition in construction sector and housing markets.

1.1 Background of the study

Chapter 1.1.1 takes a closer look at sustainability transitions. Chapter 1.1.2 discusses the innovativeness of the construction sector and Chapter 1.1.3 details institutional practices and their implementation regarding the promotion of wood in the Finnish context. Chapter 1.1.4 elaborates on the role of municipalities in advancing sustainable construction and adopting wood construction. Chapter 1.1.5 provides an introduction to the increased research interest in the use of wood in construction in Nordics, while Chapter 1.1.6 provides a brief overview of the Finnish construction sector and urbanisation in this context.

1.1.1 Sustainability and the use of wood in the construction

Sustainability transitions include long-term, multi-dimensional and fundamental transformation processes to shift established socio-technical systems towards more sustainable modes of production and consumption (Markard, 2012). Transitions are complex and often involve multiple actors and a wide range of competing and complementary technologies (Geels, 2004). The sustainability transition literature involves a power struggle between niche actors and dominant incumbents (Edmondson et al., 2019). One such transition is taking place in the

construction sector, as sustainability concerns require the adoption of more environmentally friendly construction materials and building methods.

Construction and housing play fundamental roles in enhancing societal goals for sustainable development (Toppinen et al., 2018). The construction sector accounts for as much as 39% of worldwide carbon emissions (United Nations, 2020). Furthermore, it is claimed that by developing the construction and utilisation of buildings in the EU, the total final energy consumption could be decreased by approximately 40%, total greenhouse gas emissions by 35% and the use of building materials by 50% (Herczeg et al., 2014). Using more wood in construction supports climate change mitigation because wood is a renewable raw material that collects carbon from the atmosphere and binds it for decades, especially when used in building structures. Thus, it has beneficial climate impacts compared to other construction materials (Geng et al., 2017; Hafner & Schäfer, 2017; Hildebrand et al., 2017; Peñaloza et al., 2016; NBHBP, 2019). Particularly in urban areas, the wide use of concrete construction has posed challenges to sustainability, as concrete is non-renewable and energy-intensive (e.g. material manufacturing, transportation) material (Gustavsson & Sathre, 2006). Thus, the combination of societal sustainability pressure and urbanisation has led to an increase in demand for developing and scaling up building solutions that can better respond to social, economic and environmental sustainability goals, including the global climate change challenge (Lindblad & Schaurte, 2017; Mark-Herbert et al., 2019; Lähtinen et al., 2021a).

In forest-rich regions such as Finland, Sweden and Norway, most detached houses are traditionally made of timber (Hurmekoski et al., 2018). However, in recent decades, their building technologies have evolved due to the industrialisation of building processes and pre-fabrication (Steinhardt et al., 2020). Meanwhile, wooden multi-storey construction (WMC) is still in its niche, although it has strong potential to enhance sustainability in urban housing and the development of a circular bioeconomy in cities (Toppinen et al., 2019a; Lähtinen et al., 2021b). In addition, industrial wood construction has the potential to improve productivity and quality while reducing environmental impacts (Hurmekoski et al., 2015). Furthermore, construction material companies and consumers consider the environmental quality of wood an important factor (Toivonen, 2012) to support societal efforts to increase the use of wood in construction.

The utilisation of wood in multi-storey residential and public buildings is gaining global interest, and WMC has been widely analysed (Gosselin et al., 2017; Toppinen et al., 2019a). An interview-based study by Franzini et al. (2018) on the personal perceptions of municipal civil servants showed that WMC is considered

an interesting and sustainable solution for improving urban citizens' lifestyles. Moreover, it is considered to support local and national businesses and economies. Globally, wood construction has been adopted and promoted to varying extents in various countries. For instance, the pre-fabricated housing industry in Australia and Sweden represents an early and late stage of industry emergence, respectively (Steinhardt et al., 2020). Hence, the increasing use of wood has attracted much research interest and is considered to contribute to sustainable development.

1.1.2 Innovativeness in construction sector

The construction sector has been widely criticised for its lack of innovativeness, conservatism and risk-averse nature (e.g. Kristiansen et al., 2005; Lovell & Smith, 2010; Vesa, 2014; Hurmekoski et al., 2018). Changes in construction sector are believed to 'take a long time due to slowly changing standards, norms, perceptions, education programmes and building culture' (Hurmekoski, 2018), and the field is characterised by strong path dependencies and lock-in (Hurmekoski et al., 2015).

Despite the long-standing traditions of building detached houses with wood (e.g. Høibø, 2015), large-scale industrial multi-storey construction with wooden structures is a relatively new phenomenon. The reasons for this have been the path dependencies in the construction businesses and changes in institutional practices, such as bans on urban wood building by regulation, which led to practices that promoted the usage of concrete in multi-storey construction since the early 1900s (e.g. Waugh, 2015; p. 110; Kuzman & Sandberg, 2017; Goh & Loosemoore, 2017). However, since the 1990s, the regulation allowing the usage of wood in multi-storey construction and the changes in building regulation and development of industrial wood building technologies have been potential drivers for changes in business logics in construction businesses.

Simultaneously, another (often intertwined) innovation, also referred to as pre-fabrication or industrial construction, concerns off-site manufacturing. Industrial construction has been characterised as 'disruptive' (Steinhardt et al., 2020) and radical (Levander et al., 2011), because it can transform a complex housing product into something that is more like a commodity product and that needs less on-site production (Steinhardt et al., 2020). While such changes take place at the firm level, they are bound to impact the connected actors in the housing system as well (Viholainen et al., 2021a).

Furthermore, advanced technical innovations in engineered mass-timber wood products (e.g. cross-laminated timber (CLT), laminated veneer lumber (LVL)) and the development of modular building technologies combined with a better

understanding of fire behaviour have brought about transformation in the regulations, further enhancing possibilities for WMC development (Frangi, 2009; Lindgren, 2017; Lazarevic et al., 2020; Pelli & Lähtinen, 2020).

New modular building technologies can add new dimensions for traditional construction procedures, change building culture and enhance possibilities to shift from site-bound construction to pre-fabricated construction. Lightweight wooden panels are easy to fasten, and installation occurs rapidly on-site. Thus, pre-fabrication shortens the overall construction time, hence improving construction efficiency (e.g. Stehn et al., 2002; Brege et al., 2014; Gosselin et al., 2018; Steinhardt et al., 2020). In addition, it further reduces noise and traffic at building sites, making industrial wood construction work more convenient for the environment and surrounding inhabitants (Van De Kuilen et al., 2011) Despite the alleged benefits of pre-fabrication, the adoption of new construction technologies has been relatively slow (Pelli & Lähtinen, 2020; Lindgren & Emmitt, 2017).

1.1.3 Institutional practices and their implementation

Institutions can be defined as the humanly devised rules of the game in a society as well as the social structures that create, embody and enforce those rules (North, 1991; Ahuja & Yayavaram, 2011). Institutions have a central role in both human interaction and the way firms can do business by influencing, for example their allocation of resources to productive, unproductive or even destructive activities (Baumol, 1990). Institutions also play an important role in systems of value co-creation through collaboration and cooperation within service ecosystems (Vargo & Lusch, 2015). They are composed of regulative, normative and cultural-cognitive elements (i.e. institutional practices) that add stability and meaning to social life. Institutions are highly resilient to change, but they can evolve over time and vary according to place or context (Scott, 2003).

In the housing markets, some institutions can be seen as formal (e.g. norms and regulations on land-use planning and building governed through legislation), while some as informal (e.g. tendering systems or established forms of operations to manage building processes within business networks) (Scott, 2003; Toppinen et al., 2019a). The forces of change for sustainable construction arise from general, global societal needs and developments (Whiteman et al., 2013), explicated and promoted by the UN Sustainable Development Goals (SDGs) (United Nations, 2017; United Nations, 2020). In many countries, the state plays an active role in promoting sustainability transformation in the construction through institutional practices such as legislative actions or interventions (Rasmussen et al., 2017). This is also the case in Finland, where the state has taken numerous actions to advance

transformation towards more sustainable construction. The Ministry of Environment published a roadmap to low-carbon construction in 2017. Furthermore, the use of wood in construction has been promoted by several governmental regimes since the mid-1990s by way of developing building codes, implementing policies and launching various programmes (Ministry of the Environment, 2020a; Vihemäki et al., 2020). For Finland, the present government has set the goal of being carbon neutral by 2035 and an objective of reducing the carbon footprint of construction and housing (Government Programme, 2019). One specific goal set in the government programme is to double the use of wood in construction during the government term.

Lazarevic et al. (2020) showed that the emergence of innovation in the WMC (since the 1990s) in Finland was mainly bolstered by national programmes. In WMC innovation, they identified two distinct periods of activity stimulated by government interventions. Vihemäki et al. (2020) added to the aforementioned analysis by investigating those organisations that were identified as intermediaries in industrial wood construction and low-carbon construction. In the results of their study, regime intermediaries turned out to be prominent actors. This study focuses on ministries and national organisations or programmes, while local-level governance gains less attention and is located at the outskirts of the network of actors in industrial wood construction.

However, even in the construction sector, civil servants in municipalities are important local-level governance actors. Previous findings (e.g. Franzini et al., 2018; Lindblad, 2020) show the relevant role regulators and administrators currently play in facilitating sustainability transformation. While national regulations are important institutions, their implementation takes place locally, highlighting the critical role of municipalities. Franzini et al. (2018) noted that municipalities often act as significant gatekeepers of urban development and construction, given their authority to oversee or approve zoning and land-use planning.

1.1.4 Municipality's role in advancing sustainable construction

Local-level governance actors, such as municipal (public) authorities (representing regions, communes and cities), play a central role in decision-making for and implementing institutional practices in construction business. First, municipalities may drive sustainability transformation as customers when realising public construction projects, thus influencing industry change and promoting innovation as public clients (Lindblad & Gustavsson, 2021; Gluch & Svensson, 2018; Carbonara & Pellegrino, 2019). Second, construction is guided by

national and local regulations, norms and building codes, making municipalities important institutional actors as regulators of construction (Hurmekoski et al., 2017; de Vries & Verhagen, 2016). For instance, land zoning and city planning give local authorities the power to influence urban development (Franzini et al., 2018) and to make decisions in the development of structures of housing provision (SHP) in their area. In addition, municipalities need to politically set targets for sustainability (Gluch & Svensson, 2018). In Finland, the monopoly of municipal planning and democracy of local representatives set a relatively strong political backdrop for a Finnish public planner in comparison with his/her international and even Nordic counterpart (Hytönen, 2016).

The public sector has several means for advancing sustainable and green construction, including, for example, revising and simplifying regulations and building supervision, ensuring the re-education of the workforce and launching new education programmes (Hurmekoski et al., 2017). Through public procurement practices and active end-user engagement, public sector may increase social, environmental and political value (Torvinen & Ulkuniemi 2016). The public sector can also promote innovations in construction, and its buying power is a factor that can support sustainable construction policy initiatives (Obwegeser & Müller, 2018). In particular, public clients have been identified as important for driving change and innovation in construction (Lindblad & Gustavsson, 2021; Bygballe & Ingemansson, 2014) as well as local sourcing, which supports local industries (Franzini et al., 2018). Hynynen (2016), who discussed local and regional actors in the development of timber construction, noted that cities and municipalities can enhance win–win situations as they are the beneficiaries of the regionally entrenched value chains of the wood building industry. The role of local-level governance actors as promoters of wood is especially important because markets are more concerned with cooperation than competition in value co-creation (Vargo & Lusch, 2015).

1.1.5 Increasing the use of wood in multi-storey construction in Nordic housing markets

In this dissertation, the provision of housing is referred to as SHP (Ball, 1998), a concept that comprises spheres of production, consumption and exchange of houses that work as a system of network (Ball & Harloe, 1992). SHP is the network of relationships of actors resulting in and defining what types of buildings, how many, where, to whom and by whom are being constructed. A deeper look at the background of the concept is taken in Chapter 2.1, while this chapter intends to understand specific features of Nordic and Finnish construction markets, forming the core of future housing provision needs.

Acquiring home is one of the biggest and most important purchasing decisions for many consumers in their lifetimes (Levy et al., 2008). It involves considering issues related to the following factors: the type of property (e.g. a detached house or an apartment in a multi-story building), age of the building stock, qualitative characteristics of the dwelling (e.g. floorplan) and location and source of financing, among other things (Kauko et al., 2002; Koklic & Vida, 2011). In Finland, roughly 10000 detached homes and 28000 apartments in multi-storey buildings were built in 2020 (OSF, 2020).

Compared to other European countries, a special characteristic of the Nordic housing markets is the large proportion of private ownership, either in the form of owning a detached house, owning a share of a housing company or being a member of a housing co-operative (Andersson et al., 2007). In Finland, roughly two-thirds of all apartments are owned by inhabitants (94% of all detached homes and 37% of all multi-storey apartments), and one-third of dwellings (usually multi-storey apartments) are rental houses (OSF, 2020). Consequently, residents' perceptions and value orientations on sustainability issues, including expected climate benefits, are critical (Lähtinen et al., 2021a). New detached homes often go as far as being built or planned by the residents themselves, although there are many businesses offering pre-fabricated houses in the market. In addition, from the perspective of fulfilment of sustainable urbanisation aims (e.g. UN SDGs), knowledge of demand factors in housing markets is important (Wolff et al., 2017).

The interplay of producers, consumers and regulators is also a central theme for this study, as markets with unclear growth prospects often face a chicken–egg problem where producers have to invest in new production capacity without prospective customers and consumers are not able to buy apartments because there is no supply. Related to that, little is known about how key actors in local wood construction – customers, local policymakers and builders – jointly contribute to sustainable construction and increased user value. Elements hereof involve the role of sustainability and climate considerations (i.e. carbon stock and substitution effects) in the process of consumers' decision-making.

Despite an increased need for the supply of new houses (NBHBP, 2019) and political efforts to support WMC, market development has generally been slow in Nordic countries. Currently, the proportion of the new WMC flats (i.e. two storey or more) is about 5% in Finland, while the proportion stands at 20% in Sweden (Sipiläinen, 2020; Swedish Federation of Wood and Furniture Industry, 2021). Combined with positive regulation improvements, the adoption of WMC technologies has advanced through technical innovations in engineered wood products (Lindgren, 2017; Lazarevic et al., 2020). Updates in building codes on

fire protection have enabled the construction of taller wooden buildings and made the recent increase in the usage of wood in Europe possible (Hildebrandt et al., 2017). In Finland, the growth in terms of the number of new WMC flats has been slow yet steady since about 2015; however, only approximately 1700 WMC flats have been completed so far in buildings with three or more storeys (Karjalainen, 2019). Growing interest in WMC may also be attributed to the low costs, faster construction, pleasant aesthetics and natural qualities of wood (Gold & Rubik, 2009; Gosselin et al., 2017; Viholainen et al., 2021b).

As previous research and experience from various countries indicate, the established modes of operating in multi-storey construction favour concrete as the framing material (Kadefors, 1995; Hemström et al., 2017; Mark-Herbert et al., 2019). The path dependencies derived from concrete-based industries have caused lock-ins, which have slowed the uptake of industrial wood-building technologies. This development highlights the role of informal institutional practices in hindering innovation. However, as construction is usually a domestic field of business and is significantly affected by local-level governance, considerable variations may occur in the development of the WMC market within the countries (Hemström et al., 2017; Lähtinen et al., 2019a).

1.1.6 The Finnish construction market and urbanisation

During the past decade, the construction sector in Finland has represented roughly 6% of the national GDP (Gross domestic product). In 2020, the construction sector generated a turnover of 36.9 billion euros, of which 7.4 billion euros came from residential construction, according to the Confederation of Finnish Construction Industries RT (CFCI, 2022). The industry plays a significant role in contributing to our national economy, and the unique role of house building as a consumer investment decision makes it an interesting domain for academic research.

According to Statistics Finland (OSF, 2020), in the Finnish housing stock, the proportion of detached houses and apartments in multi-storey houses is approximately 40% for both types of dwellings, and the remaining 20% comprises other types of dwellings, such as row houses and townhouses. For the past decade, multi-storey apartments have been the dominant housing type for new construction in Finland. For example, in 2019, more than 31,500 out of 42,000 completed dwellings were apartments in multi-storey houses (75% of completed dwellings). In recent years, the construction market in Finland has become rapidly concentrated in the Helsinki area and other big cities, which are commonly seen as future growth areas, whereas smaller towns and the countryside have very little growth potential. The Greater Helsinki area covers approximately one-third of all

new residential apartments (OSF, 2020). New construction seems to be focusing more on urban areas, regardless of house type. Urbanisation trends, together with sustainability challenges, facilitates changes in SHP and construction sector. Thus, the development of good living conditions and sustainable construction solutions for urban areas play a key role in adapting to climate change (He, 2019; Harju & Lähtinen, 2022).

At the current level of building sector emissions, meeting national carbon-neutrality goals (by 2035 in Finland) seems to be very challenging. Hence, the achievement of these goals primarily depends on how business actors interact and cooperate with their stakeholders, as emphasised under SDG 17 on partnerships (https://sdgs.un.org/goals). Over time, customers, industries and policymakers can co-create user value and promote climate-neutral municipalities (Edmondson, 2019). However, to effectively enhance the use of wood in multi-story construction, changes in institutional practices, such as legislation, political programmes and education, would be required (Toppinen et al., 2019a).

In Finland, the benefits of wood in urban construction have also been concretised at the official national level. For instance, the Finnish Government has set goals to increase the use of wood in construction, set national targets for the use of wood in public construction and establish supporting national programmes (Programme of Prime Minister Sanna Marin's Government, 2019; Ministry of the Environment, 2018; Ministry of the Environment, 2020b). Hence, it's fair to say that the state plays a key role in promoting wood construction.

In Finland, WMC flats are geographically concentrated in certain municipalities, increasing interest in these municipalities to advance WMC as a climate-smart solution (Franzini et al., 2018). Local-level governance actors in municipalities, especially urban planners, have much power to affect building market and industry development through formal strategies, assigning construction permits and informal measures, such as urban development strategies, public procurement processes and public-private partnerships (Mäntysalo et al., 2014; Torvinen & Ulkuniemi 2016; Lähtinen et al., 2019a). Therefore, enhancing WMC growth requires recognising the enabling factors as well as breaking free from the hindering factors in municipal governance.

Overall, regarding future market development, the prospects for WMC appear rather positive based on the increasing number of building projects. In recent years, several studies have been introduced to address the emerging WMC phenomenon (e.g. Gosselin et al., 2017; Hemström et al., 2017; Hurmekoski et al., 2018). However, the current state of the literature has remained largely unmapped. The few existing systematic reviews have focused on sustainability in

residential construction in general (Lima et al., 2021) or the perceived quality of wood as a building material (Harju, 2022). In those studies, social and economic aspects are found to be less frequently addressed in comparison to environmental sustainability, and wood material appears as a small but central node in the research from the perspective of building materials. Other reviews, such as that by de Carvalho et al. (2017), have mapped the integration of lean technology over a building's life cycle, without including the usage aspects of renewable building materials or those connected to social science perspectives.

To summarise, the construction sector plays a vital role in addressing global sustainability challenges. While the adoption of innovations has been slow, partly due to sector-specific characteristics (e.g. risk averseness and lock-in effects), innovations are emerging, causing changes in the dominant SHP. Considering WMC market growth, there is a need to better understand how the WMC market development literature is evolving. Specifically, more knowledge is needed on which market actors have been recognised in earlier research, how the actors connect to carbon neutrality objectives promoted by local-level governance, and which factors enable or hinder the market development of WMC. Better knowledge on these matters will enable WMC businesses to consider the aforementioned factors in implement their strategies, recognise the current state and obstacles for the industry and develop collaboration between other stakeholders to create better value while mainstreaming wood construction.

1.2 Purpose of this thesis and its research questions

This dissertation is composed of three scientific articles (referred to as Articles) addressing several aspects of sustainability transition in the construction sector. The purpose of the thesis, together with the research questions proposed in this chapter, guide the efforts made in the Articles to provide new knowledge on market development in the adoption of wood construction in Finland.

This study aims to create a better understanding of factors that enable or hinder sustainability transition in construction sector and housing markets. The role of municipalities and institutions in supporting the adoption of wood in the Finnish construction sector is of particular interest in this empirical study. To understand the requirements for change, Article I first synthesises the current scientific literature on the factors that enable or hinder the sustainability transition in WMC sector. As several institutions, governmental actions and regulations are found to affect sustainability transformation at the socio-technical landscape level, Article II analyses the role of the institutional practices in the

housing market from the perspective of homebuilder families in detached home markets, where wood has traditionally been used from a long time. Next, Article III investigates the role of municipalities in driving the sustainability transformation and adoption of wood in the construction sector. For analytical purposes, three research questions were formulated.

RQ1: Which factors affect the development of the wooden multi-storey construction market?

The first research question is analysed in Article I, which adds knowledge on how demand, supply and local-level governance factors contribute to the development of wood construction market. The paper relies on data available in article databases covering the literature on WMC over the past two decades (2000–2020).

RQ2: What is the role of institutional practices in the delays experienced by homebuilders during their construction processes?

The second research question is covered in Article II, which provides information on the impacts of institutional practices of local-level governance and construction business actors on delays in building processes. The study relies on data collected via interviews of Finnish homebuilder families who, as customers, have faced delays during their construction process.

RQ3: What is the role of local-level governance actors in municipalities in driving sustainability transformation towards wood construction?

The third research question covered in Article III addresses the role of local-level governance actors and businesses in transformation towards more sustainable construction by using wood. The study relies on data collected through interviews of public authorities in 292 Finnish municipalities regarding their views on the adoption of sustainable construction and wood construction in their municipality.

1.3 Positioning of the study

The overview of the dissertation clarifies how the three Articles are positioned and how the individual articles contribute to the aim of the study (in Fig. 1). The arrows outline the relationship between market actors and their interconnected actions contributing to change in construction market. The three Articles in the dissertation have been presented according to the role they play in showcasing the

research logic. Chapter 5 comprises findings from the individual Articles, which are further summarised and synthesised according to the dissertation framework.

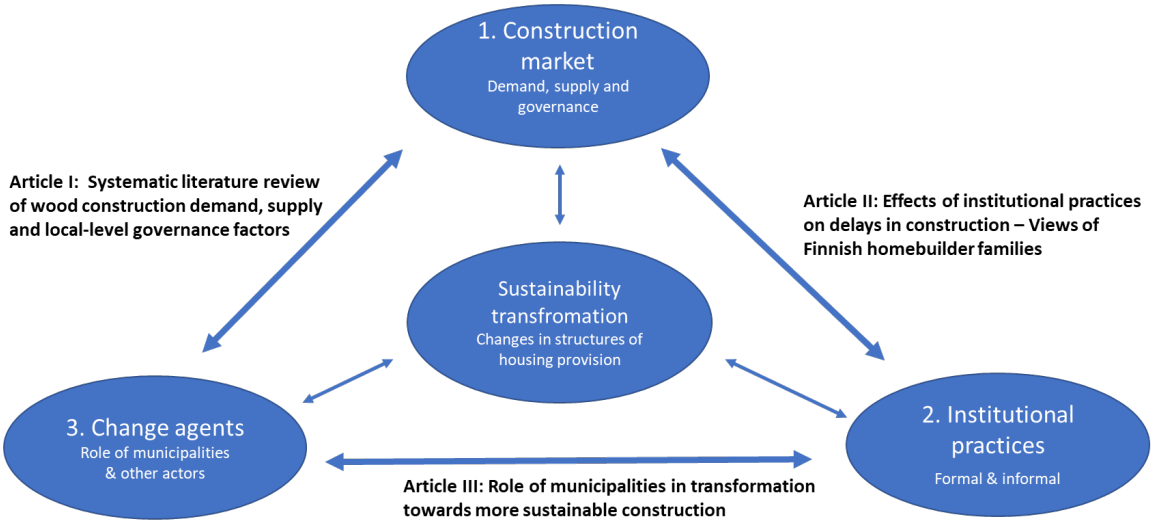

Figure 1. Overview of the dissertation framework and positioning of the Articles.

1.3.1 Research setting and analytical perspective

Three main concepts form the analytical background of this dissertation. Some of these concepts have been briefly referred to in Chapter 1. This section briefly summarises the definition of the key concepts: SHP, institutions and sustainability transition.

Structures of housing provision (SHP) refers to the provision of housing in a given market (Ball, 1998). In this dissertation, the focus is on SHP in Finland. SHP is a concept that covers spheres of production, consumption and exchange of houses that together work as a system of network (Ball & Harloe, 1992). This network of actors defines the types, numbers, location, owner and builder of a building under construction. Chapter 2.1 takes a deeper look at the background of the concept.

Institutions are the humanly devised 'rules of the game' in a society as well as the social structures that create, embody and enforce those rules (North, 1991; Ahuja & Yayavaram, 2011). This study employs an institutional perspective by focusing on the institutional practices that affect the development of housing markets. Institutions can be seen as formal (e.g. norms and regulations governed

through legislation) or informal (e.g. established forms of operations or management system) (Scott, 2003).

Sustainability transitions are long-term, multi-dimensional and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption (Markard, 2012). They are complex and often involve multiple actors and a range of competing and complementary technologies (Geels, 2004). In this study, we adopted the **multi-level perspective (MLP)** (Rip & Kemp, 1998; Geels, 2002) to research sustainability transition taking place in the construction sector, mainly in the form of adoption of wood construction in Finland. MLP consists of three analytical levels: niches (local phenomenon), socio-technical regimes (incumbent practices, national scale) and socio-technical landscape (institutions, global scale). (Smith, 2010; Markard, 2012).

1.3.2 Structure of the dissertation

First, Chapter 1 presents the construction market and the pressures for sustainability transformation as the phenomenon of interest in this study. To address the purpose of the thesis and specific research questions, this chapter introduces the key literature and theoretical background of sustainability transformation. The key areas of interest covered in the chapter included the role of wood in construction, the role of construction markets and the housing sector in Finland, the ability of innovativeness and pre-fabrication in the construction sector and the role of municipalities and other key actors in this domain.

Chapter 2 takes a deeper look at the theoretical background of the thesis, specifically emphasising SHP, institutional practices in construction and the sustainability transition concepts. Chapter 2.4 presents an analytical framework for the dissertation to guide the research.

Chapter 3 describes the methodology and quality assessment of the thesis. First, the empirical data collection and analyses of the three articles are presented, followed by a quality assessment of the dissertation.

Chapter 4 summarises the aims, main results and major contributions of the three Articles, followed by a discussion related to the research questions and the analytical framework in Chapter Five.

Chapter 6 draws the conclusions and contributions of the thesis. Managerial and theoretical implications are discussed based on the results. In the end of the

chapter, general limitations, together with future research suggestions, are discussed.

The structure of the dissertation is presented in Fig. 2.

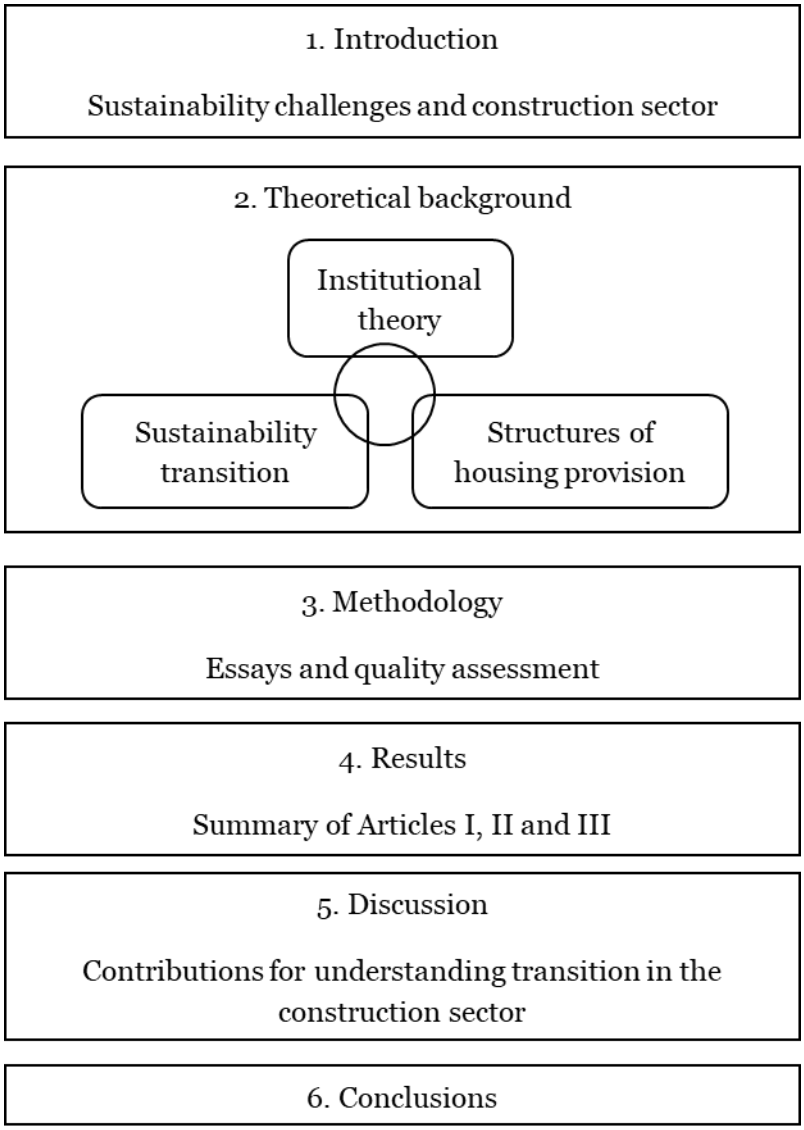

Figure 2. Structure of the dissertation

2 THEORETICAL BACKGROUND

This section focuses on the theoretical aspects relevant to the dissertation topic for examining the adoption of wood construction in the Finnish construction sector. First, the SHPs are discussed in Chapter 2.1. Then, institutional theory and practices relevant to the construction sector are briefly discussed in Chapter 2.2, with their further examination in Article II. Finally, Chapter 2.3 discusses the sustainability transition in the construction sector.

2.1 Structures of Housing Provision (SHP)

The term SHP refers to the network of relationships associated with the provision of housing at specific points in time (Ball, 1998). SHPs comprise the spheres of production, consumption and exchange, which have evolved over the course of time, forming country-specific features (Ball & Harloe, 1992). Based on the work of Ball (2003) and Burke and Hulse (2010), the production sphere comprises, for example, mechanisms that enable the supply of land through institutional practices affecting land-use planning and land ownership, along with business strategies and division of work within construction companies. In comparison, consumption is composed of, for example, the purchasing and ownership preferences of housing and the processes by which households purchase and maintain homes. The exchange sphere is related, for example, to financial institutions governing monetary instruments that enable sale, renting and use of the housing (Ball, 2003; Burke & Hulse, 2010).

SHP is not a theory on housing, it is rather an approach for describing different housing structures, which should be further evaluated with appropriate theories (Boelhouwer & van der Heijden, 1993). For example, by combining institutional theories with the SHP approach, the comprehension of the institutional processes affecting the housing system functions may be deepened. From the perspective of SHP, institutions within the spheres of production, consumption and exchange are interlinked through management systems (e.g. institutional practices and means of different actors) (Burke & Hulse, 2010). These interactions affect the governance of the whole SHP system (e.g. finance corporations, home purchasers, building developers and builders and public authorities) (Burke, 2012). In Fig. 3, an example of actors connected to the production, consumption and exchange spheres of SHPs is pictured (as presented in Article I).

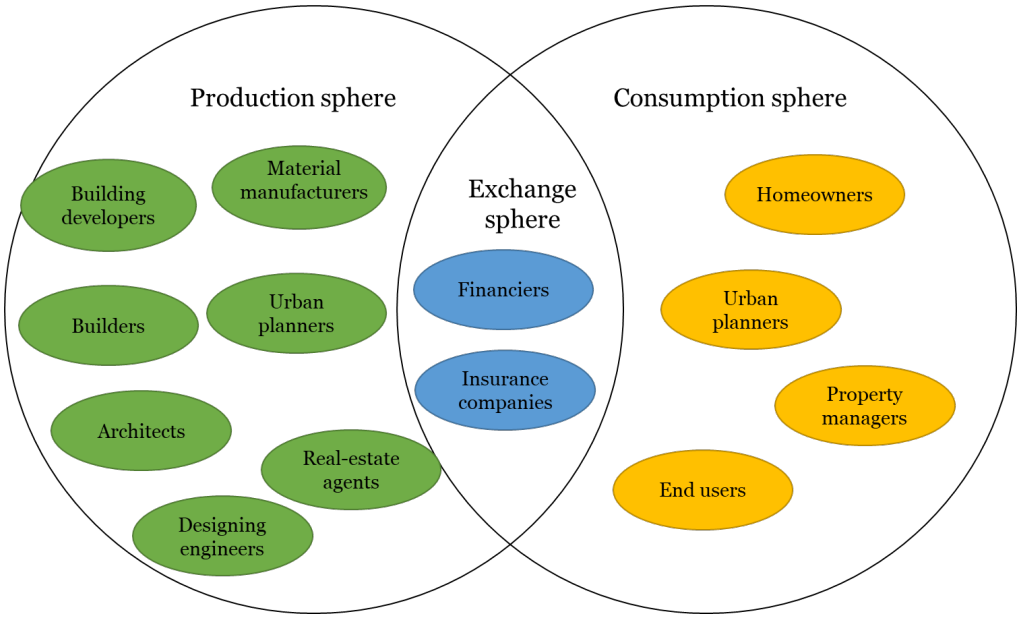

Figure 3. Actors connected to production, exchange and consumption spheres of structures of housing provision (SHP)

The production sphere consists of actors responsible for the construction process, mainly businesses; for example, building developers, builders, material manufacturers, architects, designing engineers and real-estate agents. The exchange sphere consists of financial institutions that enable changes in home ownership, that is, mainly financiers and insurance companies. The consumption sphere actors consist of homeowners, end users, property managers and urban planners as they are responsible for the fulfilment of housing needs. The role of urban planners is evident in the production sphere of the housing (e.g. cherishing building material traditions in cities) (Høibø et al., 2018) as well as in the production sphere through institutional practices such as land allocation processes and procurement processes (Lindblad, 2020).

Thus, by connecting institutional theories with the SHP, the complex nature of housing system can be concretised. For example, impacts of particular institutional practices do not necessarily reflect only production, consumption or exchange spheres of the SHP; however, they simultaneously and to a varying extent reflect all of them. As a result, when seeking solutions for specific problems in the housing system (e.g. shortening delays in detached house building processes, as addressed in Article II), understanding these interactions brings clarity in understanding the level of intervention the problems might need to be solved in either straightforward or complex ways; this might require profound

scrutiny of the whole housing system. For example, in the case of construction sector institutions, established tendering systems may affect the production sphere, while governmental regulations have a potential impact on all spheres of SHP through housing policies and financial markets (Kadefors, 1995).

In addition, some institutions in the housing system are formal (e.g. norms and regulations on land-use planning and building governed through legislation) while others are informal (e.g. established forms of operations to manage building processes within business networks) (e.g. Scott, 2003; Toppinen et al., 2019b). The level of formality affects the management systems that are available for actors to govern the SHPs (e.g. civil servants implementing land-use policies versus private homebuilder bidding tenders), even though the actors may have varying degrees of freedom in choosing their institutional practices and means (Alexander, 2005). Thus, apart from supporting the institutionalised myths (e.g. organisational image), formal organisations must seek flexibility to enhance the efficiency of their managerial practices (Meyer & Rowan, 1977). As a result, considerable variations may be found in institutional practices, even within organisations with high levels of formality.

From home purchasers' point of view, economic institutions affect housing markets through mortgage loan issuance (Kutlukaya & Erol, 2016), which, together with interest rates, comprise the main driver for demand in the housing market (Warnock & Warnock, 2008). In comparison, housing production is affected more by institutions making decisions on the regulatory environment (e.g. land-use policies and building norms) and structures of the construction sector, while the impacts of economic institutional practices are less straightforward (Warnock & Warnock, 2008). Housing suppliers may indirectly benefit from macroeconomic mechanisms by gaining market advantage through preferential market access or capital market inefficiencies, speculative land purchases and taxation factors (Ball et al., 2000).

At the EU level, the European Central Bank (ECB) controls financial markets by setting the basic frames for interest rates, which set the frame for Euribor rates. According to the Bank of Finland (2022), the 12-month Euribor is the most widely used reference rate for housing loans in Finland, with over 90% of all housing loans in the country tied to the Euribor rate. Therefore, the development of Euribor rates is important for the Finnish housing and construction sector. Another financial institution that sets a framework for bank capital adequacy, stress testing and market liquidity risk is the Third Basel Accord by the Bank for International Settlements. Locally, the banks are supervised by the Financial Supervisory Authority, which regulates and guides them on, for example, capital adequacy, risk

management and home loan collaterals. These financial institutional practices form the base for the exchange sphere actors of the housing system to operate.

We already know about the 'traditional' economic processes and norms related to, for example, mortgage markets; however, contemporary global megatrends (e.g. climate change, urbanisation and demographic changes) (e.g. Lützkendorf et al., 2011) have become critical to SHPs through several institutional processes and norms emerging in international policies (e.g. European Commission, 2014; Ecodesign Directive, 2009). Although regulation has positive impacts on improving housing standards, enhancing sustainable development and creating business opportunities for forerunner building companies (e.g. Andersson et al., 2007; Lützkendorf et al., 2011), it may also cause additional costs, uncertainty and delays in the building processes (e.g. Al-Khalil & Al-Ghafly, 1999). Delays are among the most crucial obstacles to the success and performance of construction projects (Zarei et al., 2017).

From the perspectives of home purchasers, inefficient regulation has especially been found to decrease the diversity of the supply of dwellings in the housing market (Puustinen & Kangasoja, 2009) and delimit the possibilities of house buyers to make choices in their home design (Gibler & Tyvimaa, 2014). From the house builders' point of view, impractical regulation increases construction costs and decreases the possibilities for innovation diffusion (Puustinen & Kangasoja, 2009), which have been found to be crucial for mind-set renewal in the construction sector (e.g. Holt, 2013). Furthermore, extensive regulation may decrease the number of new buildings constructed (Mayer & Somerville, 2000).

2.2 Institutions

Institutional theories focus on tracking the existence of 'distinctive forms, processes, strategies, outlooks, and competences, as they emerge from patterns of organisational interaction and adaptation' (Selznik, 1996). One aim of institutional theories is related to the aforementioned, which explains issues such as the scenarios in which institutional elements arise and the extent to which organisational structures are a result of institutionalisation and the extent to which institutionalisation improves organisational performance. (e.g. Zucker, 1987).

According to institutional theories (e.g. DiMaggio & Powell, 1983; Zucker, 1987; Selznik, 1996), organisations are influenced by normative pressures for adopting similar patterns of behaviour as those of others (i.e. through institutional practices) to increase coordination and reduce the need for information processing, thus creating efficiency benefits. As information is necessary for any

economic activity and none of the actors has more than a limited range of expertise, institutions play a vital role in reducing construction-related risk and uncertainty (Ball, 1998). In addition, since power is distributed unequally among individual actors in social systems, collaboration is a form of being part of a network of relationships and communication flows (Booher & Innes, 2002). However, institutional practices may also constrain behaviour and hinder changes that might have a positive impact on industries in the form of adopting innovations (Kadefors, 1995; Eriksson, 2013).

The evolution of institutionalism can be traced back to several decades, during the development of which the concepts of 'old' and 'new' institutionalism have emerged (Scott, 2008). While 'old institutionalism' follows development paths that lead to institutional divergence, 'new institutionalism' addresses the issues of institutional homogenisation (DiMaggio & Powell, 1983; Meyer & Rowan, 1977). Homogenisation of practices can be approached by employing the concept of industrial isomorphism, which is composed of power (coercive isomorphism), attraction (normative pressures) and mimesis (mimetic processes) (DiMaggio & Powell, 1983). In addition, Beckert (2010) added competition as a fourth mechanism of industrial isomorphism.

Institutions play a central role in human interaction and firms' business by influencing, for example, their allocation of resources to productive, unproductive or even destructive activities (Baumol, 1990). Institutions are composed of regulative, normative and cultural-cognitive elements that add stability and meaning to social life. For example, in housing markets, the institutional environment is composed of political, environmental, social and demographic, economic, legal and administrative practices and norms, which affect the performance of the overall housing system (Burke, 2012). They are highly resilient to change; however, they evolve over time and vary depending on places or contexts (Scott, 2003). In addition, along with business organisations, political–legal institutions also cause isomorphic pressures, for example, by imitating 'efficient' tax laws, labour laws or environmental standards representing 'regulatory competition' between states; the latter has become a central feature of political economies (Beckert, 2010).

Moreover, previous findings demonstrate the relevant roles of regulators and administrators in facilitating sustainability transformation through institutional practices. While national regulations are important, their implementation takes place at locally. Franzini et al. (2018) noted that municipalities often act as important gatekeepers of urban development and construction, given their authority to oversee or approve zoning and land-use plans.

Institutions can be divided into two categories: formal (e.g. laws, norms and regulations) and informal (e.g. tendering systems and homogenised forms of operations) (Scott, 2003; Toppinen et al., 2019b). The level of formality affects the management systems available for actors to govern the SHP (e.g. civil servants implementing land-use policies versus private homebuilder bidding tenders), even though the actors can have varying degrees of freedom for choosing their institutional practices and means (Alexander, 2005). Thus, along with supporting the institutionalised myths (e.g. organisational image), formal organisations are required to seek flexibility to enhance the efficiency of their managerial practices (Meyer & Rowan, 1977). Consequently, there may be considerable variations in institutional practices, even within organisations with high levels of formality.

Regulations work as an important force for change in construction. For example, a change in the Swedish building code in 1994 allowed the use of timber as a framing material in multi-storey buildings (Levander et al., 2011), and this has led to an increase in WMC in Sweden. For example, WMC now occurs at a much higher tempo in Sweden than in Finland (Toppinen et al., 2019a). The study by Toppinen et al. (2018) of the environmental concerns motivating WMC in Finland and Sweden found that the emphasis on sustainability is driven by changing regulations (reflecting societal needs). Giesekam et al. (2016) noted the need for 'new regulatory drivers to complement changing attitudes if embodied carbon is to be established as a mainstream construction industry concern'.

In this study, the role of institutions is investigated, mainly from ecological aspects of sustainability pressure to the construction sector. Both formal and informal institutions are considered to put pressure on industry development and changes in the SHP. While the empirical focus in Article II is on institutional practices causing delays to homebuilder families in single-family home markets, this study aims to contribute to the construction sector more widely, especially to industrial wood construction and WMC development.

2.3 Transformation towards sustainability in construction

The concept of sustainable development consists of social, environmental and economic pillars (Hill & Bowen, 1997; Elkington, 1997). Thus, sustainable construction denotes the creation of a built environment that incorporates actions supporting the sustainable well-being of social (human), environmental and economic systems. A sustainable built environment is achieved by using resources and operations that have a positive and sustainable impact on these systems (Hill

& Bowen, 1997). This study focuses on environmentally sustainable construction, while leaving the social and economic aspects aside. In the empirical part of the study, particularly in Article III, the respondents defined sustainable construction in practice, referring mainly to low-carbon or green construction and sometimes to wood construction.

Transformation towards more sustainable construction solutions calls for innovations and cooperation. According to Dubois and Gadde (2002), the construction industry is a loosely coupled system in which a strong reliance on standardised components and interfaces does not advance innovation or technical development. Moreover, project-based firms in this industry need to manage technological innovation and uncertainty across organisational boundaries within networks of interdependent suppliers, customers and regulatory bodies (Gann & Salter, 2000). Complex construction projects bring together a diverse range of professionals who design, build and manage the projects and are active at different stages of the construction process (Slaughter, 2020), thus adding to the challenges of change. Therefore, the transformation towards sustainable construction is not without problems.

Concrete and steel are traditionally used structural materials for large-scale buildings, such as non-residential and multi-housing buildings, and while the use of wood has increased, the use of wood is still not a common practice (Gosselin et al., 2017). Previous studies have highlighted this strong path dependency regarding the use of well-established construction methods and materials (Mahapatra & Gustavsson, 2008; Viholainen et al., 2021a). Wood provides new opportunities for construction companies (e.g. through pre-fabrication opportunities); however, challenges in adopting new practices in construction also exist (Brege et al., 2014; Steinhardt et al., 2020; Viholainen et al., 2021a).

To understand (sustainability-related) change in construction, several scholars have used multi-level frameworks. Gluch and Svensson (2018) offered a 'layered understanding of institutional work related to changes in the built environment driven by a sustainability agenda' and adopted a multi-level approach, where the organisational field, organisation and project levels are analysed to advance sustainability in a municipal context. Steinhardt et al. (2020) and Gann and Salter (2000) observed actors representing the infrastructural framework, technological support, supply network and projects and constructing firms. Bygballe and Ingemansson (2014) investigated innovation in construction by paying attention to the network of involved actors as well as the organisational levels; they analysed the achievement of innovations in construction using three organisational levels: project, company and industry. Finally, the study by Vihemäki et al. (2020) on the

facilitation of WMC and intermediaries also showed different actors and activities at multiple levels and focused on, for example, ministries and organisations attending to national aspects.

2.3.1 Multi-level perspective on sustainability transitions in construction industry

The concept of transition towards sustainability is defined as a fundamental transformation towards more sustainable modes of production and consumption (Markard, 2012). Sustainability transitions are long-term, multi-dimensional and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption (Markard 2012). They are complex and often involve multiple actors and a range of competing and complementary technologies (Geels, 2004). One such ongoing transition can take place in the construction field and relate to the selection of construction materials and techniques to attain sustainability objectives. Increasing the use of wood as a construction material is an example of such a transition.

MLP (Rip & Kemp, 1998; Geels, 2002; Geels, 2004; Geels & Schot, 2007) is a framework for understanding sustainability transitions, which provides an overview of the complex, multi-dimensional changes in socio-technical systems. MLP consists of three analytical levels: niches (where radical innovations are created), socio-technical regimes (which are locked in and stabilised on several dimensions) and an exogenous socio-technical landscape. MLP is not considered a grand theory but rather a middle-range theory building on a combination of institutional theory and business studies (Geels, 2010). MLP analyses a socio-technical system that consists of niches, regimes and landscapes (Smith, 2010). In MLP, niche often represents the local scale, the regime the national scale and the landscape the global scale (Markard, 2012).

Transitions are crucially dependent upon activities within niches, where selection pressures prevailing in regimes are less evident. Niches provide 'protective spaces' for path-breaking, radical alternatives whose performance may not be competitive against the selection environment prevailing in the regime (Rip, 1992, p. 91; Kemp et al., 1998). Historically, niches that provided seeds for transitions had to overcome the constraining influence of regimes, branch out, link up with wider change processes and drive transformations in those regime structures for the long term. Many niches have not expanded successfully or survived for a long time. (Smith, 2010).

Niche-level development is based on the production of valuable lessons, the articulation of supportive institutional requirements and the commitment of a growing network of actors, including potential investors and mainstream users (Raven, 2007). Niche actors need to make considerable cognitive, institutional, economic and political efforts; they need to be persuasive to multiple administrations and stakeholders that may change over time to be able to compete with the incumbent regimes, outperform them and finally take over (Smith, 2010).

The regime level is considered relatively stable as an outcome of active resistance to changes by incumbent actors. Policymakers and incumbent firms can often be conceptualised as forming a core alliance at the regime level, which is oriented towards maintaining the status quo (Geels, 2014). Highlighting this dependency, Lindblom (2001) provides an illustrative metaphor: 'If the market system is a dance, the state provides the dance floor and the orchestra'. (Geels, 2014). The concept of a socio-technical regime contains 'policy' as one dimension, in addition to technology, user practices, science, cultural meaning, infrastructure and industry (Geels, 2002).

In the socio-technical landscape (such as the EU level), several countries are taking steps in supporting the transition towards the bioeconomy (EU bioeconomy strategy, 2018). The EU bioeconomy strategy contributes to the European Green Deal, which aims to transform the EU into a fair and prosperous society with a modern, resource-efficient and competitive economy that would have no net emissions of greenhouse gases in 2050 and whose growth is decoupled from resource use (The European Green Deal, 2019). Finland was one of the first countries in the EU to set up a nationwide bioeconomy strategy in 2014 (Finnish Bioeconomy strategy). The strategy aims to accelerate the deployment of a sustainable European bioeconomy while contributing to the European Green Deal. In Finland, the bio-built environment, based on wooden buildings and the use of renewable construction materials, is among the top activities in this respect (Bosman & Rotmans, 2016). Furthermore, the government of Finland has set an ambitious goal of double the use of wood in construction during the government term (Government Programme, 2019). Correspondingly, the Ministry for Environment has launched a special national programme for supporting the use of wood in construction and other products (Ministry of the Environment, 2018). These institutional practices aim to promote sustainability transition and highlight the vital role of the state and municipalities as promoters of wood construction at the landscape level.

Environmental problems cannot be addressed by incremental improvements and technological fixes; however, they require radical shifts, called 'sustainability

transitions', to new kinds of socio-technical systems (Elzen et al., 2004; Grin et al., 2010). The central aim of transition research is to conceptualise and explain how radical changes can occur in the way societal functions are fulfilled. Thus, the unit of analysis is primarily situated at the 'meso'-level of socio-technical systems (Geels, 2004).

2.3.2 Adoption of wood construction and the MLP

The success of the sustainability transition and the increased use of wood in the construction field may face resistance from incumbent actors, despite institutional support. Transition literature involves a power struggle between niche actors and dominant incumbents (Edmondson et al., 2019), where incumbent regime actors may use different types of resistance strategies to hinder development (Geels, 2014). As discussed previously, socio-technical landscape-level pressure for sustainability transition includes, for example, regulation and EU-level strategies, whereas regime-level pressure consists of construction companies and other actors adapting to or resisting the pressures. Transitions are seen as crucially dependent upon activities within niches, where selection pressures prevailing in regimes are less evident (Smith, 2010).

In the construction industry, many relatively novel wood construction businesses and innovations, especially in the WMC field, can be observed to be taking place at the niche level. Among other resistance strategies, incumbent firms and policymakers often form a core alliance at the socio-technical regime level, oriented towards maintaining the status quo (Geels, 2014). While the construction industry is adopting change, the need for policy mixes to create incentives for actors and support efforts towards sustainability remains important. Meanwhile, as suggested by Edmondson et al. (2019), feedback loops from the industry actors towards regulators remain vital.

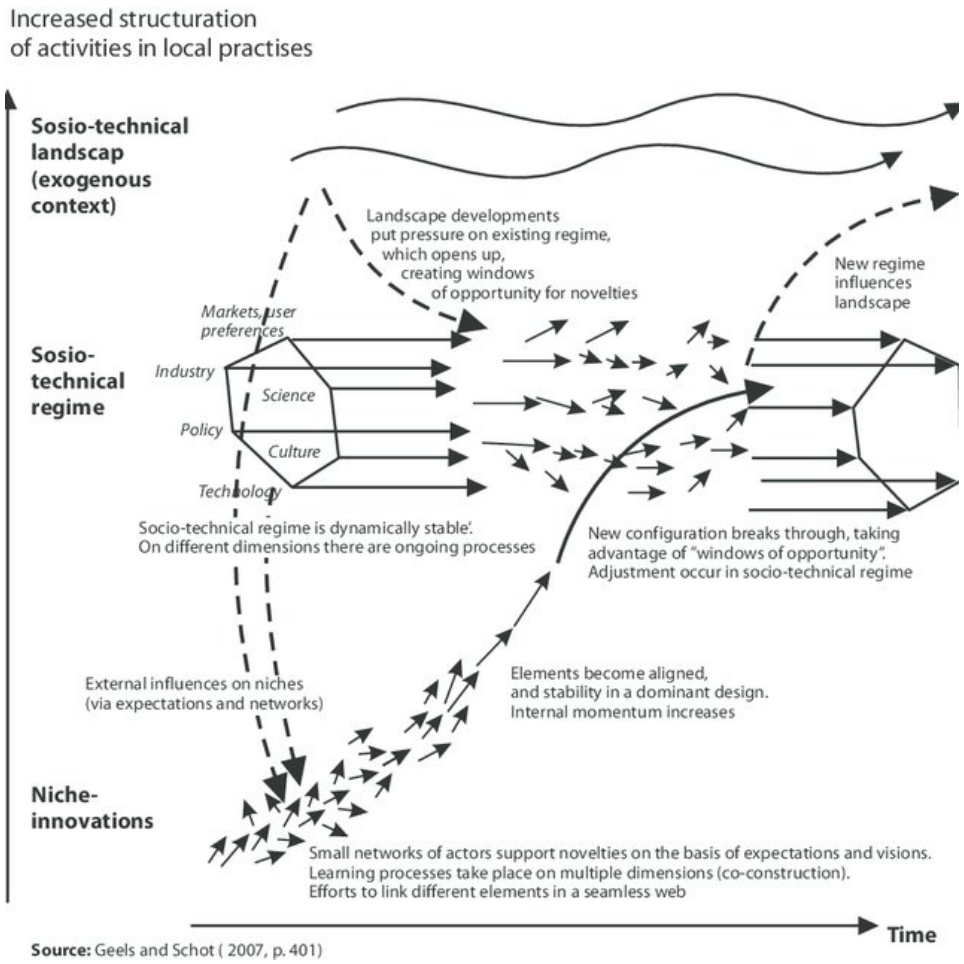

Figure 4. Sustainability transition, as described by Geels and Schot (2007).

At the landscape level, global sustainability challenges require changes at the institutional level. As discussed previously, much emphasis is currently placed on increasing energy efficiency and reducing overall carbon dioxide emissions in the construction industry. According to the framework, these landscape developments put pressure on existing regimes in the construction industry, creating opportunities for novelties.

The socio-technical regime translates into an existing SHP with dominant industry actors, policies, technologies, science, cultural meanings and user practices. As the multi-storey construction sector in Finland is dominated by a few large construction companies relying on concrete buildings, resistance naturally occurs towards innovations when aiming to sustain stability at the regime level (Geels & Schot, 2007). According to the framework, few configurations and changes occur

in different dimensions of the regime when the industry adjusts to institutional pressures from the landscape level.

In the niche-innovations level, industrial wood construction (especially related to WMC) consists of networks of actors, such as CLT producers, element manufacturers and wood construction companies, which are still relatively new and small in size compared to the dominant actors in construction. Standardisation of skills, products and services required to break from niche innovation is still underway before becoming widely adopted as part of SHP in the socio-technical regime. Taking advantage of this 'window of opportunity' created by the demand for sustainable solutions is crucial for the adoption of wood construction as a mainstream solution. The change can be observed as supported by external influences in the form of promotion of wood construction by the state through public construction and potential incentives. It has yet to be observed how changes in regulation support or hinder wood construction in terms of formal institutions.

2.4 Analytical framework for the dissertation

Following the previous discussion regarding the theoretical background of the study, an analytical framework for the dissertation was formed. As the sustainability pressure can be seen to affect institutional practices in the housing market, the focus of the study is on the specific role of agents and triggers for change, especially in the adoption of wood construction. A specific aim of the study is to provide a better understanding of the factors that enable or hinder sustainability transition in the construction sector and housing markets.

This framework provides support for empirical data collection and analysis; however, it is noteworthy that it has been developed through an iterative process between theory, literature and empirical analysis. This analytical framework is not intended to work as a theoretical framework; however, it merely provides guidance for the Articles and their analysis. In Fig. 5, the Articles have been positioned according to their research aims and contributions.

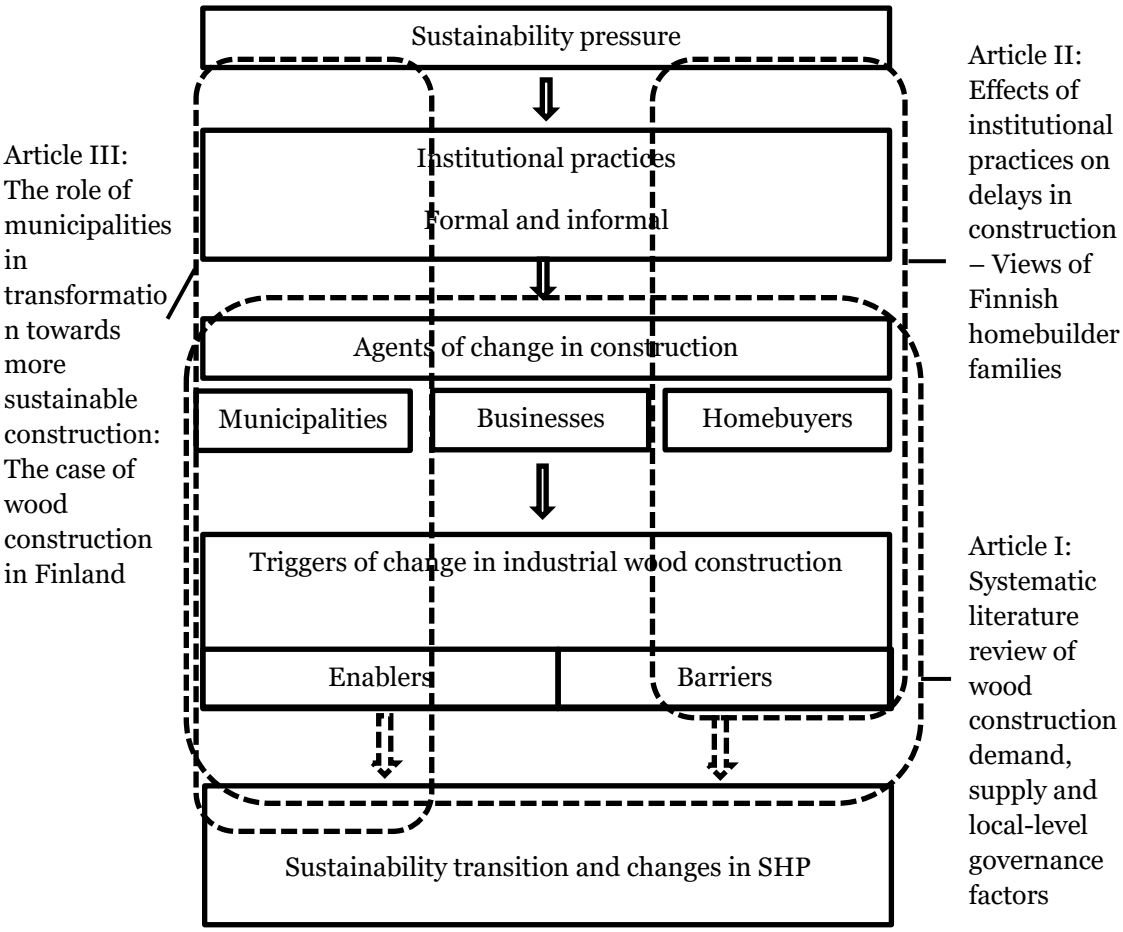

Figure 5. Analytical framework for the dissertation.

Article I provides an extensive review of the current literature on WMC development in Nordic countries. Through the aforementioned analytical framework, this article aims to identify agents of change in the industrial wood construction sector in relation to demand (homebuyers), supply (business actors) and local-level governance (municipalities). Furthermore, the article synthesises potential triggers of change in wood construction by analysing factors that work as enablers of or barriers to the increased use of wood in construction. The article applies the SHP framework for thematising findings. Finally, the literature review aims to fill the gaps found in the literature, suggest future research areas and guide the role of the other research articles covered in this study.

Article II provides an overview of Finnish homebuilder families that are facing challenges in their construction projects. The article aims to provide new knowledge on the role of institutional practices in the context of single-family home construction. The article analyses empirical data by applying the SHP framework together with institutional practices, as identified by Kadefors (1995). Article II focuses on the experiences of homebuilders in the institutional practices followed by local-level governance actors and construction businesses. In particular, the article highlights municipalities as local-level authorities governing land-use planning, zoning and granting building permits required for construction projects. For the dissertation purposes, the article further provides an overview of several formal and informal institutions affecting the development of SHP.

Article III emphasises the role of municipalities in the sustainability transition. It takes a deeper look into the role of municipalities in the construction sector. Empirically, the article covers several practices adopted by municipalities to advance sustainability in construction. For dissertation purposes, the article further analyses triggers of change in wood construction. The article identifies enablers of and barriers to industrial wood construction based on the views of decision makers in local-level governance, enhancing understanding of prerequisites for changes in the SHP and sustainability transition in construction sector.

3 METHODOLOGY

This chapter describes the underpinnings employed in this dissertation and the three research articles in terms of the research methodology and philosophical concepts used. Chapter 3.1 discusses the research paradigm of this dissertation. Chapter 3.2 presents the empirical data collection technique used and analyses of the three Articles. Chapter 3.3 provides the assessment of quality of the dissertation in terms of trustworthiness and validity of the study.

3.1 Research paradigm and methodology

The term 'paradigm' refers to the philosophical assumptions of the research. The pre-suppositions and views of the world underlying different paradigms vary. Thus, the research topic and phenomenon, together with the researcher's view of the world, influence the choice of paradigm. The chosen paradigm and the background assumptions adopted in the research form the basis for the research and contribute to the definition of the research objectives, implementation methods and results. Therefore, it is essential for the researcher to be aware of the background assumptions of their work and the limitations they impose (Puusa & Juuti, 2020). These assumptions consider research ontology, epistemology and methodology (e.g. Tronvoll et al., 2011). This chapter discusses the understanding of the research ontology, epistemology and methodology adopted in this dissertation.

Ontology refers to the nature of reality; thus, it is concerned with the following factors: what kind of reality exists, how it looks, what entities are there in that reality and how they interact (Tronvoll et al., 2011). Ontological considerations are based on questions about the nature of social entities, ranging from objectivistic to subjectivist views (Creswell, 2013). Ontological assumptions are argued to influence and guide all subsequent assumptions the researcher possesses, which makes it fundamentally important for the researcher to recognise and explicitly address them (Tronvoll et al., 2011).

Epistemology is closely related to ontology, as it concerns the researcher's assumptions about the bases of knowledge, especially how the researcher perceives the world and how these perceptions are communicated to others as knowledge (Burrell & Morgan, 1979). Knowledge can be seen as hard, objective and passable (positivism), or soft, subjective and experiential (anti-positivism). Positivism seeks the regularities of phenomena and cause-and-effect relationships to explain or predict events, while anti-positivism seeks unique information and is committed to people's perceptions (Puusa & Juuti, 2020). Tronvoll et al. (2011) state that

epistemology ultimately comprises two dimensions: one that concerns how the world is perceived and the second that defines the relationship between the researcher and his research subject.

This dissertation leans towards constructivism as an ontological stance. The research is context specific and views different stakeholders' insights on sustainability transformation within the construction sector. The main concepts of the study on institutions, SHP and sustainability transformation are social constructs developed by practitioners or scholars. Considering the epistemological assumptions, it leans towards anti-positivism (interpretivism). Evolution or interpretivism can also be seen as the main ontology for the MLP of the sustainability transition framework (Geels, 2010), supporting the use of these assumptions.

The study is data driven and can be considered using a mixed methods approach, even as it leans towards a qualitative research design in line with epistemological and ontological assumptions. From a methodological perspective, an abductive research approach is pursued in this study to support empirically based theory building (Timmermans & Tavory, 2012). Both qualitative and quantitative data and analyses were employed, depending on the article at hand. In the case of Article I, a literature review based on an analysis of peer-reviewed articles is presented, which utilises thematic coding based on the literature searches. In Articles II and III, qualitative thematic coding was used based on data collected with semi-structured surveys. Quantitative analyses are based mainly on the use of secondary data to support the findings of qualitative analyses.

3.2 Empirical data collection and analysis

Table 1 summarises the empirical data collection of the research Articles. Each of the Articles consists of its own primary data utilizing both qualitative and quantitative approaches. Use of semi-structured surveys is highlighted in large sample sizes, whereas the final analysis in most of the cases consists of a specific sub-sample (through thematic coding), which is subsequently analysed thoroughly. Chapters 3.2.1, 3.2.2 and 3.2.3 introduce the research methods used in the articles in more detail.

Table 1. Summary of type of the data and method of analysis used in the Articles.

Article	Article I: Systematic literature review of wood construction demand, supply and local-level governance factors	Article II: Effects of institutional practices on delays in construction – Views of Finnish homebuilder families	Article III: The role of municipalities in transformation towards a more sustainable construction: The case of wood construction in Finland
Research question addressed	RQ1: Which factors affect the wooden multi-storey construction market development?	RQ2: What is the role of the institutional practices in the delays experienced by homebuilders during their construction processes?	RQ3: What is the role of local-level governance actors in municipalities to drive sustainability transformation towards wood construction?
Type of data	Literature, peer-reviewed articles on wooden multi-storey construction, published between 2000 and 2020	Qualitative data gathered from homebuilder families via phone interviews during January 2015	Two types of qualitative data: a survey (via telephone) and personal interviews of municipal decision makers conducted in 2020
Sample size	Final sample of 42 peer-reviewed articles out of initial screening of 7117 articles	Data sample of 2404 homebuilders with 661 respondents of whom 168 interviewees had experienced delays in construction project.	Survey sample of 293 municipal representatives and in-depth interviews with nine civil servants and five business representatives
Method of analysis	Systematic literature review following the PRISMA guidelines Data analysis in four stages with in-depth content analysis of the final sample	Quantitative and qualitative analysis: thematisation of data in using theory and data-driven approaches	Mixed methods: survey data was analysed using thematic coding and descriptive results Personal interview transcripts used to enrich the findings on practices adopted by the cities

3.2.1 Article I: Systematic literature review of wood construction demand, supply and local-level governance factors.

By following the PRISMA method, the article captured literature based on articles published between 2000 and 2020 in international peer-reviewed scientific journals. Searches were carried out in two databases (Scopus and Web of Science) using pre-determined search words for titles, abstracts and keywords. The pre-determined keywords were defined based on the existing information received from the literature employed. The search words were tested and refined by the researchers based on the initial findings to include key literature in the research area. This was done to enhance the validity (i.e. no exclusion of relevant literature, exclusion of literature entirely from different fields of research) of the material to be found.

As the method of analysis, a systematic literature approach was employed, since it is a transparent, rigorous and detailed methodology that is used to support decision-making (Tranfield et al., 2003). This method may also be used to build theory by accumulating knowledge and evidence after analysing a large number of studies and methods, thereby increasing the consistency of the results and conclusions (Akobeng, 2005; Denicol et al., 2020). This study follows the PRISMA guidelines of Moher et al. (2009), and the systematic literature review was performed in the following four stages:

The first phase of the literature review process comprised the general identification of the literature. This was executed using the combined sets of search words defined by the research team based on the literature that was known to be broadly related to the scope of this study. As an outcome of the database searches executed during the identification phase, 7117 document results were received in Scopus and 5491 in Web of Science, respectively. After the exclusion of irrelevant journals and titles, 825 articles remained for further screening (440 in Scopus and 385 in Web of Science). In this phase, duplicates were also removed from the search results, resulting in a total of 696 papers.

The second phase of the literature review involved screening of the 696 articles, which were conducted by the research team as a case-by-case evaluation. In this phase, 528 articles were excluded based on a full abstract reading using preliminary addressed exclusion criteria. The list of excluded studies mostly consisted of articles that did not address wood construction or had a strictly technical focus (i.e. no information to add knowledge on WMC market development). After the screening phase, 168 articles were left for further consideration in the eligibility assessment.

The third phase, i.e. eligibility assessment, included a complete reading of papers of 168 articles. Each full-text article was read independently by two researchers, who assessed the eligibility of the individual studies in terms of their contribution to this literature review. After the individual readings, the research team discussed the evaluation results together to strengthen the validity of the results. As an outcome of the eligibility assessment phase, 126 full-text articles were excluded from further reading. Articles were excluded if they did not address multi-storey buildings, did not focus on the market development perspectives or focused on other types of buildings than residential construction. In addition, some articles were excluded due to their unavailability in electronic format. Furthermore, a few articles were found to be published in non-peer-reviewed journals; hence, they were excluded. After the eligibility assessment, 42 papers were included in the initial material of this study.

As the final phase of the literature review, all 42 peer-reviewed articles were thoroughly analysed. First, the focus at this stage of the analysis was to categorise the contents of the materials into the themes of enabling factors and barriers that affect the potential for WMC market development. As an analytical framework to link the results with housing markets, the SHP framework was employed. The categorisation process also included identification of the key actors whom the literature mentioned to be connected with different WMC market actions. In this phase, the research methods and analytical approaches used in the 42 studies were also studied to gain knowledge on the approaches that had addressed the topic of increase in WMC market demand in the previous studies. This was to explore any possible addition of, for example, an understanding regarding different types of methodological and analytical developments needed in academic research to provide new information on the WMC in the context of housing markets in the future.

3.2.2 Article II: Effects of institutional practices on delays in construction – Views of Finnish homebuilder families

The analysis employed qualitative data gathered from homebuilder families via phone interviews in January 2015. The data gathering process was targeted at 2,404 families, who had acquired building permits in Finland to start a detached house construction project in the fall of 2014. The data sample for analysis consisted of 661 respondents, of whom 168 interviewees, representing 26% of the 661 respondents, had experienced major delays in their building projects.

Overall, the survey consisted of 24 questions, of which questions on the level of pre-fabrication of the building project were addressed in the analysis of this study

together with open-ended questions related to delays faced by the respondents. Data were quantitatively and qualitatively analysed in all three stages.

The quantitative analysis was based on calculus of frequencies and the statistical non-parametric Mann–Whitney U test (also known as Wilcoxon rank sum test), executed with IBM SPSS Statistics software to check whether statistical indications of connections between the existence of major building delays and the level of pre-fabrication could be found.

In the qualitative analysis, data thematisation was employed to comprehend the magnitude of institutional practices as factors having negative effects on detached house building projects. As a method, thematisation is suitable for evaluating a specific phenomenon in concrete contexts, especially as it asks respondents to describe their internally meaningful experiences without pre-determined structures (Holloway & Todres, 2003). In this study, thematisation was employed both as data-driven and theory-driven approaches to independently identify the categories of delays from theoretical assumptions and the details recognised in reference to theoretical background on institutions and SHP.

3.2.3 Article III: The role of municipalities in transformation towards a more sustainable construction: The case of wood construction in Finland

The study relies on mixed methods and two types of the data: a (telephone) survey and personal interviews conducted in 2020. The survey results provided us with a comprehensive view of the current practices of Finnish municipalities in the area of promoting sustainable construction. The interviews also provided us with more detailed examples of the practices adopted to enhance sustainable development and helped us thoroughly understand the reasons and strategic aims that influenced these practices.

First, the survey conducted among municipal representatives consisted of 293 (out of 294) mainland Finland municipalities that were contacted for a telephone interview. The survey was directed at civil servants responsible for construction in their municipality. An open-ended format for the questions was used to provide the respondents with the scope to raise any topic and mention any number of practices. Data collection took place during October–November 2020, when sustainability-related issues in construction were widely promoted in Finland; wood construction was emphasised in the new government programme by Prime Minister Marin (Government Programme, 2019), and in September 2020, national targets for increasing public sector wood construction were launched

(Ministry of the Environment, 2020b). It provided us with a comprehensive but relatively acute understanding of the local-level governance mechanisms that support sustainable construction, especially wood construction.

Second, to gain a deeper and richer understanding of municipalities' roles in transforming construction, personal interviews were conducted with representatives of selected municipalities. These interviews took place in autumn 2020, that is, in parallel with (or soon after) the telephone survey and before analysing the survey results. Nine civil servants who represented seven municipalities were interviewed. Furthermore, five business representatives were interviewed to gain insights into how businesses view municipalities' activities on these matters. Our respondent selection for personal interviews was based on both intensity of knowledge and richness in perspectives (Creswell, 2013, pp. 156–158). To cover the former aspect, information-rich cases were aimed; that is, municipalities that we knew (based on public data) had an interest in more sustainable construction. Particularly, municipalities that had promoted sustainable construction in their operations by way of, for instance, launching wood construction were searched for in-depth interviews.

3.3 Quality assessment of the research

The quality assessment of the research mainly uses the following three concepts: trustworthiness, reliability and ethics. Naturally, these concepts are interconnected and complicated entities (Puusa & Juuti, 2020). This chapter discusses the trustworthiness, reliability, validity and ethics assessment of the study in more detail.

3.3.1 Trustworthiness

Trustworthiness refers to the extent to which readers of the study accept the results as true and trust that the research data have been properly collected and carefully analysed. While objectivity is a central goal of science, complete objectivity is practically impossible in social science research. Objectivity refers to the ability to distinguish a researcher from a research subject so that the researcher's own assumptions and measures do not affect the characteristics and results of the research subject. The trustworthiness of qualitative research is enhanced when the researcher seeks to identify his or her own subjectivity. In this case, the aim is to

increase objectivity by identifying and highlighting one's own subjectivity (Puusa & Juuti, 2020).

In this study, the processes of data collection and analysis of each research Article have been made as transparent as possible to improve the trustworthiness of the research process (as covered in Chapter 3.2). Most of the data was collected from semi-structured survey and interview, and then the data were coded. Subsequently, a discussion of quality assessment of the research (in this Chapter 3.3) followed, including validity, reliability and ethics assessment of the study to provide readers a better view to assess the trustworthiness of the research. As scientific writing includes the rigorous use of references to original sources of knowledge, the researcher's own thoughts are mostly present in the Discussion and Conclusions (Chapters 5 and 6, respectively). Furthermore, the general limitations of this research are discussed in Chapter 6.3.

3.3.2 Reliability

In qualitative research, reliability can be addressed in several ways. It often refers to the similarity or stability of responses when using multiple sets of data (Puusa & Juuti, 2020). A key part of the analysis is the so-called inter-coder agreement between researchers, which was based on commonly agreed rules for coding and thematisation in the analysis of research data together with transcriptions, in which case several researchers conducted the analysis (Creswell, 2013).

All the empirical data in the study (especially related to Articles II and III) consisted of open-ended interview questions written in text format. The coding and thematisation were mainly carried out by the author and supported by the views of the co-authors in each of the individual research articles at hand. The analysis phase included discussions with the co-authors involved in that study.

In connection with the literature review (in Article I), the coverage and reliability of the data were enhanced using two different datasets (data triangulation) obtained by the same data collection and analysis methods by two researchers separately. The analysis of the data was still carried out independently by at least two researchers before the actual synthesis (researcher gypsum). The process was carried out and documented using the PRISMA method, which was used in the literature reviews. At every step of the process, the researchers sat down and agreed on codes and themes as well as checked obscure articles. The use of this inter-coder agreement to analyse research contributed to improving the quality and reliability of research.

3.3.3 Validity

The validation of qualitative research involves an attempt to assess observations as accurately as possible, as described by the researcher and participants. Validation also suggests that all research reports are the author's own presentations. A researcher can use so-called 'validation strategies' to document the accuracy of his or her research (Creswell, 2013).

This study used several validation strategies to enhance the quality of the research. First, triangulation between different data sources, methods and researchers was implemented, as described earlier. Each of the research articles contains a detailed description of the research methods to provide the readers with the opportunity to assess the accuracy and credibility of the results. Furthermore, all three research articles went through a peer-review process (at least two anonymous reviewers per article) and were published in well-established scientific journals.

3.3.4 Research ethics

Ethics refer to the ethical principles followed by the researcher, which concern both the research methods and analysis phases. Research must seek to achieve good things for the people it targets and not cause harm or endanger the people under study. This can be challenging in practice when people become interdependent (Puusa & Juuti, 2020.)

From an ethical point of view, two key themes emerged from the starting point of my doctoral thesis on the ethical challenges of related research: affiliation and data management. In affiliation, it is important to identify relationships with research funders and their potential to influence research issues and results. Research funding for this doctoral thesis has been obtained from several sources that have made the research financially possible. Two of the articles (Articles I and III) were created through independent research projects in which the projects were financed mainly by public or non-profit organisations, in particular by the Ministry of the Environment and the European Regional Development Fund. The research topic and competitiveness of Finnish wood construction have been a topic of common interest for financing organisations. However, the funders have not influenced the research topic, data collection, analysis or results. In this respect, the affiliation has not jeopardised the independent, high-quality research conducted for this dissertation.

However, a few ethical challenges related to data management and transparency could be recognised. First, existing empirical material was collected through

interviews and therefore raised privacy and confidentiality issues (especially in the case of consumer interviews). The processing of the material was carried out by the concerned persons for the investigation according to the GDPR (General data protection regulation) principles, and the management of the material was strongly protected. The first-hand research material was not made publicly transparent (excluding material from the literature review, where there are no similar challenges) and the materials were anonymised during the coding and transcription phases. The anonymity of individual respondents was maintained, as the research data were quite extensive for a qualitative study (100–300 respondents) and did not contain sensitive material. In turn, the lack of publication and the closure of some of this material may pose a downturn in the transparency of the research. In this sense, a compromise had to be made in which full transparency of the material had not been made available due to privacy concerns. However, the methodology of the data collection of studies, the content of the data and the research questions have been described as comprehensively as possible in each of the Articles. In addition, the Articles went through the peer-review process.

4 SUMMARY OF THE ARTICLES

In this chapter, the main results and conclusions of the three Articles are presented. Chapter 4.4 summarises the findings according to the analytical framework of the dissertation.

4.1 Article I: Aims, results and conclusions

Article I aims to create a better understanding of WMC market development by conducting a systematic literature analysis of international peer-reviewed studies published between 2000 and 2020. It focuses on the role of WMC in the housing markets in terms of factors like demand, supply and local-level governance. The article (1) synthesises the key barriers and enabling factors for WMC market growth; (2) identifies the actors connected to WMC market development; and (3) summarises the research methods and analytical approaches used in the previous studies. As a systematic method, the article employs PRISMA guidelines to conduct literature searches in two databases: Web of Science and Scopus. By using pre-determined keywords, the searches resulted in a sample of 696 articles, of which 42 full articles were included in the content analysis after the selection procedure.

As a general outcome, the analysis shows that the number of published peer-reviewed articles on WMC has increased, especially after 2017, indicating an increasing interest among scholars in WMC. Regarding the geographical focus of the studies, the results indicate that WMC market development research has been dominated by studies connected to the Nordic region. In reference to the SHP framework, the analysis showed that information in the literature solely addressed views linked with production and consumption spheres, while no information related to the exchange sphere existed in the 42 peer-reviewed articles employed as the material of this study.

Related to the first aim to synthesise key barriers and enabling factors for WMC market growth, the study resulted in categorisation of eight general themes that emerged in the literature. These themes were named as follows: (1) sustainability in building, (2) system development, (3) innovations, (4) business collaboration, (5) stakeholder awareness, (6) institutional changes, (7) urban planning and (8) market demand. The reviewed literature provided a more nuanced understanding of production sphere enablers and barriers, while the availability of information on the consumption sphere was considerably scarcer. The results showed cost-efficiency gains from industrialised pre-fabrication and perceived sustainability benefits by consumers and architects, which enabled a diffusion of WMC market

with aspects related to system development and institutional changes. Meanwhile, the barriers were mostly connected to 'system development' (e.g., lack of knowledge and information, limited experience with building with wood), 'stakeholder awareness' (e.g. negative perceptions of product features such as fire safety, water control, durability), and 'business collaboration' (e.g. lack of collaboration, lack of table relationships). In addition, in relation to urban planning, discrepancies in actor perception of the land allocation process and deficiencies in municipality capacities for public procurement processes were mentioned in the literature.

Regarding the second aim, key actors covered in the literature were businesses (e.g. contractors, element manufacturers and architects) involved in the wood construction value chains, while residents and members of the WMC business ecosystem, such as public authorities, were seldom addressed. Because construction industry requires a high degree of specialisation at local and project levels, future development would require incorporation of a highly diverse set of actors and related skills in the production sphere (Toppinen et al., 2019a). Small-scale actors often have limited resources to use new technologies and acquire new skills. Possibilities to start using new building systems and changing business logics may be supported through collaboration activities (Brege et al., 2014), which would enhance the accumulation of special expertise and knowledge to build with wood as a part of project-driven business ecosystems (Viholainen et al., 2021a).

Regarding the third research aim on approaches used in the previous studies, 67% (28 out of 42) articles used a qualitative approach, 24% (10 out of 42) used a quantitative approach and 9% (4 out of 42) used a mixed approach. Among the articles that used a qualitative approach, the most used way to describe the study was to call it a case study or a multiple-case study (n = 16). Almost all of the articles with a quantitative approach were described as a survey (n = 9). The most used data collection method among the qualitative articles was interviews, which was used in 25 out of 28 articles, although only 14 of these articles relied solely on interviews as a data collection method. Other data collection methods in the qualitative approaches were the use of focus groups, literature collection, secondary data collection, surveys and workshops. In the quantitative articles, nine out of ten used a questionnaire/survey to collect the data.

As a conclusion of our study, more research is needed on the factors that affect the demand for WMC homes (i.e. consumption sphere) in the housing markets. So far, the focus of research on WMC apartments has mostly been on their supply (i.e. production sphere) in the housing markets, while consumer expectations for WMC homes have gained considerably less attention. In addition, information on the

role of financial issues, such as the role of mortgages and insurances (i.e., the exchange sphere) affecting both the supply and demand of homes, is entirely lacking in relation to WMC market development. However, to make a change in the construction sector, WMC must also be viewed in the context of the housing markets, not only through supply mechanisms mainly connected with technological benefits and cost efficiency.

The results of the article suggest that some of the key enablers include benefits arising from increased pre-fabrication, such as increased material efficiency in construction processes, resulting in lower material costs and rapid installation (Persson et al., 2009; Roos et al., 2010; Markström et al., 2018). In addition, wood is perceived to bring benefits to the WMC, especially among wood manufacturing companies and architects (Nordin et al., 2010; Riggio et al., 2020; Peters et al., 2020), but this push is not sufficient, at least not yet, for rapid acceleration of the WMC business. As a barrier to system development, the lack of experience of using wood in multi-storey construction and the path dependencies with concrete and steel construction continue to be the key hindrances for mainstreaming of the WMC (Mahapatra & Gustavsson, 2008; Riala & Ilola, 2014; Hemström et al., 2017). However, the demand-side enablers and barriers remain unknown due to a gap in research.

Although housing markets function as a system of production, consumption and exchange, our results show that the information on WMC market development is still under-developed. In reference to structures of housing production (SHP) (Burke & Hulse, 2010), actors in the exchange sphere are important as intermediates in the housing markets (e.g. mortgages, insurances) (Österling, 2017), but according to our results, no research has been conducted on their roles in the WMC market.

4.2 Article II: Aims, results and conclusions

The purpose of Article II is to address institutional practices as causes of delays in detached house building processes in Finland. According to the collected data, 168 (26%) of the respondents faced delays during their building projects. Reasons for delays were mostly connected to building permits, finance and general life situations. In addition, from the purchasers' viewpoint, practices associated with the construction sector institutions were found to be significant causes of detached house building project delays (altogether 68% of all experiences of delays) in different phases of project implementation.

Based on the findings and in reference to the SHP, for homebuilder families, most of the identified causes of delays were caused by institutional practices of public authorities or homebuilders' own skills and capabilities within the production sphere. The results on the role of public authorities in building delays indicate that the level of formality of a particular institution does not necessarily mean well-functioning institutional practices. Instead, a high level of institutionalisation may produce inefficiencies (also noted by Meyer & Rowan, 1977). In the case of the empirical data, bureaucracy related to acquiring building permits seemed to cause delays in the project. These were not only caused by the regulation itself but also by 'human factors' related to the persons in charge (e.g. building inspectors' summer holidays prolonging the building permission processing). Compared to aspects in production, issues linked to the exchange sphere played a minor role (e.g. financing for house building). In addition, problems connected solely to the consumption sphere (e.g. inability to make decisions on purchasing or unavailability of appropriate house models) were not mentioned at all.

In reference to the SHP, the results showed that in the context of Finnish detached home-building processes, production and consumption spheres are closely intertwined, due to which the usage of SHP seemed to provide useful insights into the multi-dimensional nature of institutions, practices and means affecting the detached house purchasing system, especially in the context of Finland. As a difference to the speculative building processes (i.e. professional builders act as managers in the production sphere), Finnish homebuilder families have two-fold position both as customers in the consumption sphere and organisers of work in the production sphere.

As a theoretical contribution, the article identified connections between institutional structures (Kadefors, 1995) and empirical building project phases, indicating the applicability of institutional approach in studying detached house building within the SHP system. However, theoretical development is needed to more transparently describe the roles of actors within and between specific institutions. This illustrates how different actors, with their real-life practices, are positioned in the SHP system, affecting the implementation and outcomes of building processes. In Article II, a preliminary examination was made by positioning the results in the SHP framework. In a broader context and future research, this approach might bring new avenues for analysing the obstacles and drivers of change in the housing markets.

Regarding managerial implications, an important outcome is that although the detached house building process is characterised by complexity (i.e. many issues linked to pre-planning and planning, preparation and building phases), the

processes handled by house building companies had functioned quite well. In all, less than 5% of the delays caused by the companies could be identified. Article II also covers insights into the functioning of pre-fabrication in construction. According to the results, the level of pre-fabrication did not have a statistically significant relationship with the occurrence of major building project delays. Thus, from the perspective of potential business development towards even higher levels of pre-fabrication, the result indicates that, as such, there are no special business risks related to the level of pre-fabrication from purchasers' point of view in relation to construction sector institutions.

Compared to industrial building processes (e.g. multi-story houses) managed by professional building developers, the detached house building processes are run by private house purchasers, usually without any professional education in construction. Moreover, since detached houses are usually built as one-off projects, purchasers do not benefit from the institutional accumulation of knowledge and skills. This creates a knowledge gap between different actors in the construction process and prohibits institutional practices related to 'Learning and Routines' to strongly involve or evolve in the process. This major difference compared to other building types in the SHP tends to decrease the quality of construction (e.g. Ball, 1998). To develop the project organisation in the detached house business, building companies could take a bigger role as a 'node' of information sharing and in the diffusion of skills, such as through the provision of services, which would enhance risk management among purchasers and companies themselves. For example, if purchasers were more familiar with the bureaucracy and documentation needed during the building process, along with the financial requirements and general issues related to scheduling, the processes of individual purchasers would also become more predictable from the building companies' point of view.

If considered as obstacles within companies, formal institutions, such as processes and norms in 'governmental regulations' and 'standardisation of skills and knowledge', may discourage the development of innovations (see, e.g. Blayse & Manley, 2004; Gibler & Tyvimaa, 2014; Lähtinen et al., 2019b). However, the results show that possibilities exist to discover new business solutions in detached house markets by approaching the roles of different actors in building projects from new angles.

4.3 Article III: Aims, results and conclusions

Article III investigates the role of municipalities in driving sustainability transformation in construction, particularly in relation to wood construction. Here, sustainable construction denotes different actions taken to advance low-carbon or green building, where the promotion of wood construction is a potential avenue and this an area for focus.

The empirical study relies on data collected in Finland through a comprehensive survey of municipalities and qualitative interviews. Article III poses the following (empirical) research questions: 'What specific actions are municipalities taking concerning sustainable construction?' and, in particular, 'To what extent and how is wood construction promoted in the municipalities?' A description of these municipal activities contributes to the analysis of the role that municipalities (as representatives of the public sector) play in the ongoing sustainability-related societal transformation that involves construction. To gain a deeper and richer understanding of municipalities' roles in transforming construction, personal interviews were conducted with nine representatives of seven municipalities that had an interest in enhancing sustainable construction.

The results showed that most of the Finnish municipalities (57%) had goals and practices related to enhancing sustainable construction. A total of 166 municipality representatives replied with practices related to sustainable construction, and 127 municipalities denied having such practices. Key factors in municipal considerations are goals like energy efficiency and carbon neutrality. Building according to regulations and norms related to construction also influences municipal activities, highlighting the importance of institutional practices. Other common practices included construction of long-lasting and sustainable buildings, use of renewable energy sources and promotion of wood construction. The results show that Finnish municipalities are taking steps towards more sustainable construction. Wood construction is gaining attention; however, it still plays a minor role in municipal activities when compared to other important sustainability aspects such as energy efficiency issues, life cycle thinking and sustainable energy solutions.

The study seeks various drivers of and barriers to wood construction in municipalities. The majority of the municipalities (191 or 65% of all Finnish municipalities) stated that there were no barriers to wood construction, while 97 municipalities discussed barriers to wood construction. The most important theme that arose was perceived higher costs, especially in connection to large buildings. Other major concerns were the poor economic situation of the particular

municipality, prevailing traditions in the construction and restricting building regulations. Respondents' comments on prevailing negative attitudes (or even prejudices), limited supplies and a lack of skills seem to characterise the perceived state of the wood construction industry. These views highlight the need to gather both knowledge and experience to advance the wider adoption of wood in construction.

When considering the drivers of wood construction, the results provided very positive views. Only 19% of the respondents found no factors in promoting wood construction in their municipality. The most important driver for wood construction was land-use planning and zoning, which was mentioned by 40 municipalities. Municipalities may enhance wood construction by zoning land for wood construction. Another notable factor was the role of local actors, indicating municipalities' interest in building and supporting local resources and businesses. Other important factors included enhancing wood construction through existing traditions (e.g. detached homes traditionally built with wood), implementation of environmental objectives to new building areas, general positive demand for wood construction and subsidies or other support to wood construction. In addition, some municipalities actively run their own construction and promotion projects that implement wood construction.

Personal interviews with municipality representatives supported the survey results while contributing to public sector work for sustainable construction in more detail. The strategic focus for many municipalities lies on decreasing carbon emissions and energy savings, considering construction as a critical strategic area for making effort. Despite this, only a few municipalities explicitly considered wood construction as a tool to promote sustainability targets. Large-scale wood construction (such as large public buildings and multi-storey construction) was seen as a novelty, and municipalities had typically only realised smaller wood construction. Wood construction was often perceived to be a more expensive option, and support from the Ministry of Environment was seen as fairly important in speeding up many processes and pilot projects. The role of the ministry was seen as a promoter of wood construction in terms of not only supportive funding but also providing information, instructions and raising new ideas. The national targets for wood construction (launched in September 2020) had not yet had any notable effect among the municipalities.

Locally, cooperation and collaboration between different actors (businesses, citizens and experts in the field) was important while considering the promotion of wood construction. While the respondents noted different actors' roles in wood construction, the emerging overall picture gives the municipality a key role in

influencing how construction develops with linkages to local politics as well. To conclude, despite several positive examples of drivers of wood construction, it seems that it would take time before municipalities adopt wood construction more extensively. Simultaneously, their position at the intersection of different actors and activities within housing provision provides a sound base for promoting sustainable construction.

4.4 Summarising the findings

This chapter briefly summarises the findings of the research articles and their contributions to the research questions.

4.4.1 Factors affecting WMC market development

Related to the first research question, Article I covers factors that enable or hinder the development of WMC market based on an extensive literature analysis. According to the results, enabling factors for WMC market diffusion include benefits from pre-fabrication (e.g. reduced material costs and efficiency in construction processes) together with perceived sustainability benefits. The findings were further supported in the study provided in Article III, with views from the Finnish municipalities, where the drivers for wood construction were found to be the practices like land-use planning and zoning adopted in the municipalities. Other drivers that municipalities mentioned were their interest in supporting local businesses, enhancing existing construction traditions and implementing environmental objectives in new building areas and supportive institutional practices. In addition, some municipalities actively run their own construction and promotion projects that implement wood construction supported by national programmes promoting wood construction. This is in line with the findings of Article II on the importance of well-functioning local-level governance practices to enhance the successful implementation of building projects.

Barriers to wood construction consist most notably of a lack of experience with wood, higher costs associated with wood construction, and strong path dependencies with concrete construction, as identified in the literature covered in Article I. These findings were also supported by views from the municipal decision-makers in Article III, who mentioned limited supplies and restrictive building regulations as key barriers to mainstreaming WMC market development. However, it is important to acknowledge that the majority of Finnish municipalities covered in Article III reported no existing major barriers.

While the empirical findings contribute to the existing literature by supporting the findings, more research would be valuable on how wood construction value chains can challenge the dominant concrete-based construction regime in markets where wood construction has gained more market share. Furthermore, as concluded in Article I, the focus in the current scientific literature has been on aspects related to the production sphere of the SHP system, whereas no research was found on the exchange sphere and only limited studies related to the consumption sphere.

4.4.2 Role of institutional practices in delays experienced by homebuilders during their construction processes

Related to the second research question, Article II studied the role of institutional practices in causing delays in construction. The empirical data consisted of results from Finnish homebuilders, creating an interesting base for studying a construction project in a simplified setting where one actor, the homebuilder, covers both the production and consumption spheres of the SHP system. The results of the study acknowledge the role of both formal and informal institutions. In particular, regulation and bureaucracy by public authorities, together with homebuilder's lack of skills and standardisation, were found to be the most common causes of delays during the construction of such projects. Article III further found that national programmes promoting wood construction have induced gradual changes and led to some municipal pilot projects, thus highlighting the active role of the state and ministries.

In Article II, in reference to the SHP framework, institutional practices causing delays are mostly affected within the production sphere. However, the role of pre-fabrication in delays in construction processes was not evident. This is also in line with the findings in Article I, which highlight increased pre-fabrication as a driver for WMC development. In Finnish detached house construction, the industrialisation of wood building processes has been a dominant regime. From the perspective of WMC market development, research focusing on technological advancements may be a sign of the next phase in the transition from the niche level towards a new regime in a more sustainable construction system. In Article II, issues linked to the exchange sphere played a minor role, even though the financing capabilities of homebuilders were often discussed. According to the results, institutional practices causing delays that are solely related to the consumption sphere were not mentioned in the study at all.

4.4.3 Role of local-level governance actors in municipalities to drive sustainability transformation towards wood construction

The third research question was dedicated to studying the role of local-level governance actors in municipalities to drive sustainability transformation towards wood construction. In Article I, key actors covered in the existing literature are mainly business actors (e.g. contractors, manufacturers and architects) linked with the wood construction value chains, whereas the literature from the residential perspectives and local-level governance mechanisms was found to be more limited. This supported the aim for Articles II to focus on residential perspectives on construction challenges and Article III on municipal decision-makers' roles. Article II found the role of public authorities in relation to building delays, indicating that the level of formality of a particular institution does not necessarily mean well-functioning institutional practices, it may instead produce inefficiencies (as noted by Meyer & Rowan, 1977).

Article III further studied the goals and practices related to enhancing sustainable construction, together with drivers and barriers for wood construction. Key factors in municipal considerations are energy efficiency and carbon neutrality goals, while the promotion of wood construction is less frequently considered. Many of the municipalities already had carbon neutrality goals set at the strategic level. Regulations and norms related to construction also influence municipal activities. While the respondents emphasised that collaboration and cooperation are essential when considering wood construction promotion, the results highlighted the important role of municipalities in influencing how construction develops, with linkages to local politics as well. Municipalities have several tools and practices (especially power in land zoning activities) to influence the development of the SHP. To conclude, despite several drivers of wood construction and the power to influence, municipalities are gradually adopting wood construction. They are positioned at the intersection of different actors and activities within housing provision; thus, they have a central role in driving sustainability transformation in the construction.

5 DISCUSSION

This chapter summarises the research findings in relation to the analytic framework (Chapter 2.4). This first includes discussion on sustainability pressure in the construction sector, together with an understanding of how changes in institutional practices are challenging the current socio-technical regime in the construction sector. Next, the discussion includes different stakeholders in the SHP and their roles as potential agents of change. This is followed by a discussion on triggers of change in the form of factors that enable or hinder the development of industrial wood construction. Finally, on the basis of the results, the discussion summarises the prerequisites for sustainability transition.

Sustainability pressure in the construction sector is linked to aims of lowering the carbon emissions of buildings and construction processes (Giesekam et al., 2016; Geng et al., 2017). This dissertation mainly covers environmental aspects of sustainability (Chapter 2.3), and the use of wood in the construction to lower carbon footprint and create carbon storage in buildings (Hildebrandt et al., 2017; Gustavsson & Sathre, 2006).

In Article III, different sustainable development practices in municipal construction were discussed and recognised, for example, energy efficiency of the buildings, carbon neutrality goals, consideration of rules and regulations, life cycle thinking and construction of long-lasting buildings, usage of renewable energy solutions, promotion of wood construction and land-use density in urban environment. The range of sustainable development practices highlights not only the complexity of the sustainability pressure itself but also the requirement for a variety of aspects that need to be taken into account when considering making changes in the system of housing provision.

Institutional practices have emerged in various forms to enhance sustainability development (Chapter 2.2). These practices exist at different levels of the socio-technical system, as covered in the MLP framework, referred to as niches, regimes and landscape (Geels, 2002, 2004). In the socio-technical landscape, the Paris Climate Act and, for example, the EU Green Deal put pressure on nations to cut their carbon emissions.

In the regime level, national goals for reducing carbon emissions and supportive regulation and programmes for enhancing the use of wood in the construction sector have been launched to support the landscape-level aims. The current system of housing provision at the regime level needs to adapt to these changes, which can mean new construction materials, building methods, housing types, changes in the business models and culture in which construction companies operate.

Furthermore, changing consumer preferences and end user needs together with increased regulation and requirement for transparency in ecological aspects affect the regime-level change.

At the niche level, several regions, municipalities and companies are adopting aims towards carbon neutrality along with other aspects of sustainability. These aims may vary with their emphasis on how to achieve carbon neutrality. In Article III, the role of municipalities in this respect was analysed. In the Finnish municipal sector, sustainability was seen as consisting of a set of aims and practices. The role of wood construction was seen as only one way of promoting sustainability in municipalities, together with energy efficiency, carbon neutrality and enhancement of life cycle of the buildings. Most of the municipalities saw more enabling factors than barriers towards the adoption of wood in the construction.

Institutional practices were further analysed in Article II from the consumers' point of view. In this case, the empirical material consisted of detached homebuilders. Several reasons for delays in the construction processes were found, including regulation and bureaucracy related to building permits, finances, life situation and finding a suitable plot. These reasons were found in both formal and informal institutions, highlighting the role of municipalities as critical actors in granting building permits and land zoning. In relation to WMC or public construction, it is noteworthy that previous studies have found tendering systems and procurement processes to form another important informal institution (Kadefors, 1995), that may function as value creation mechanism (e.g. Lindblad 2020; Torvinen & Ulkuniemi 2016). However tendering systems did not highlight in the results related to homebuilders' experiences in Article II, which can be interpreted as a difference between the construction processes of these different housing types.

Agents of change in the form of active stakeholders are needed to kick-start doing things differently for the transformation of construction sector towards sustainability. While new companies and innovations are born typically at the niche level of the socio-technical system (Geels et al., 2004), key actors in the dominant regime need to adopt new practices to mainstream wood construction. Next, the role of possible agents of change in wood construction is discussed.

Construction projects and the industry consist of network actors with different roles, often described as loosely coupled systems (Dubois & Gadde, 2002). The focus in this dissertation was on consumers and municipalities along with the business actors in construction industry. While Article I covered all of these actors by examining studies in the WMC, the subsequent Articles took a closer look first

at homebuyers in single-family housing (Article II) and then the role of municipalities (Article III).

In reference to structures of housing production (SHP) (Burke & Hulse, 2010), actors in the exchange sphere are important intermediates in the housing markets (e.g. mortgages, insurances) (Österling, 2017); however, according to the results (in Article I), no research was available on their roles in the WMC market. Current literature on WMC market development has focused mostly on actors connected to the production sphere, while knowledge of actors in the consumption sphere is far more limited. Key actors covered in the literature include businesses, for example, contractors, element manufacturers and architects, together with members of the WMC business ecosystem, such as public authorities and residents. In addition, regarding business actors, most of the research information on companies connects directly to wood industries (e.g. manufacturers of modules). Because construction industry needs a high degree of specialisation at local and project levels, future development would require a highly diverse set of actors and related skills to be incorporated in the production sphere (Toppinen et al., 2019a). Small-scale actors often have limited resources to use new technologies and acquire new skills. Possibilities to start using new building systems and changing business logics may be supported through collaboration activities (Brege et al., 2014), which enhance the accumulation of special expertise and knowledge to build with wood as a part of business ecosystems (Viholainen et al., 2021a; Lähtinen et al., 2021b).

Other important business actors include architects who design wood buildings (Roos et al., 2010). Several studies have concluded that architects' perceptions of wood vary between different markets and are two-fold in relation to the qualities of wood material. The positive qualities of wood relate to lightness, cosiness and ecological traits, whereas negative concerns relate to fire safety, moisture, durability, higher costs, and complexity (Hemström et al., 2011; Mallo & Espinoza, 2015; Markström et al., 2018; Ilgin et al., 2021). While wood is commonly used and accepted by architects for small-scale construction (such as detached homes), especially in the Nordic countries, their perception is more reserved considering the use of wood in taller buildings (Ilgin et al., 2021) and in an urban context (Høibø et al., 2018).

Triggers of change for industrial wood construction to evolve were analysed in several phases of the study by considering factors that enable and hinder the development of wood construction. First, enabling factors for WMC market diffusion, perceived sustainability benefits, especially among consumers and architects, together with benefits from pre-fabrication (e.g. material costs and

efficiency in construction processes) were found to be crucial according to the literature review analysed in Article I. Wood is seen as ecological, durable and aesthetically appealing among consumers (e.g. Harju, 2022). These are important drivers for industrial wood construction even though the physical properties of houses are given less value by the consumers compared to intangible factors related to, for example, lifestyles and milieus (Lähtinen et al., 2021b). Previous literature has found that urban consumers are the most prejudiced against wood building; thus, the supply of homes meeting their value expectations is of critical importance for WMC market diffusion. (Lähtinen et al., 2021b).

Similar findings regarding the barriers and enablers were found in Article III among municipal decision makers. While most of the municipal decision makers (65% of all municipalities) saw no major hindrances to wood construction, the most recognised ones were perceived higher costs related to wood construction, poor economic conditions of the municipal and prevailing construction traditions. The last is in line with previous literature on path dependencies and lock-in effects (e.g. Mahapatra & Gustavsson, 2008; Riala & Ilola, 2014).

Increased regulation and bureaucracy as an institutional practice may cause major hindrances for construction and were identified to be causing delays for homebuilders in Article II. Similar findings on the role of institutional practices as hindering factors for the WMC (e.g. land zoning, public procurement) were made in Article I. Furthermore, intensive regulation has historically hindered WMC development through tight fire regulations, which originated from city fires in the 1800s and early 1900s (Waugh, 2015; Kuzman & Sandberg, 2017). The market diffusion of WMC has only recently gained momentum in Finland, as changes in building codes were made after the 1990s (Hildebrandt et al., 2017; Vihemäki et al., 2020). Furthermore, innovations related to engineered wood products (such as CLT) have enabled the development of construction technologies and increased pre-fabrication.

Yet, the lack of experience from using wood in multi-storey construction and the path dependencies with concrete and steel construction continue to be the key barriers for mainstreaming the WMC market development in accordance with previous literature (Mahapatra & Gustavsson, 2008; Riala & Ilola, 2014; Hemstöm et al., 2017). This view was further supported by the municipal decision makers interviewed for Article III. Yet, the market diffusion of WMC may be supported by the perceived resource efficiency benefits (e.g. cost reductions, flexibility, rapid construction), which have also been benefits for industrial wood construction in the detached housing market (e.g. Steinhardt et al., 2020).

Sustainability transition in the construction sector calls for changes in the SHP. The ambition of the dissertation is to contribute to the transformation of SHP and construction industry towards more sustainable future. As discussed, wood construction can be seen as a solution to enhance sustainability in the form of substituting more climate-burdensome materials while acting as a carbon sink in the building for decades.

Previous literature on sustainability transition (e.g. Geels, 2002, 2004; Elzen et al., 2004) found that transitions took a long time in the current socio-technical regime. Industrial wood construction in Finland can be seen as being on the edge of wider adoption in the current system of housing provision, still dominated by large construction companies that are mainly producing concrete buildings.

Interestingly, several factors affecting the adoption of wood construction can be seen as both barriers and enablers. For example, higher costs associated with wood construction are noted in the existing literature (e.g. Mahapatra et al., 2012; Mallo & Espinoza, 2015) (Article I). High construction costs were also recognised as barriers to the adoption of wood construction by the municipal decision makers in Article III and causing delays in construction (Article II). At the same time, cost effectiveness obtained through pre-fabrication was seen as an enabling factor for wood construction by municipal decision makers in Article III. This supports the existing literature on the benefits of pre-fabrication (e.g. Stehn et al., 2002; Persson et al., 2009; Roos et al., 2010; Gosselin et al., 2018; Steinhardt et al., 2020).

Figure 6 summarises Chapter 5 and research findings related to the analytical framework. Research findings highlight the empirical results based on the three research Articles. As the findings mostly focus on describing enablers and barriers related to the adoption of wood construction in Finland, overcoming these prejudices may help mainstream the use of wood in the construction sector.

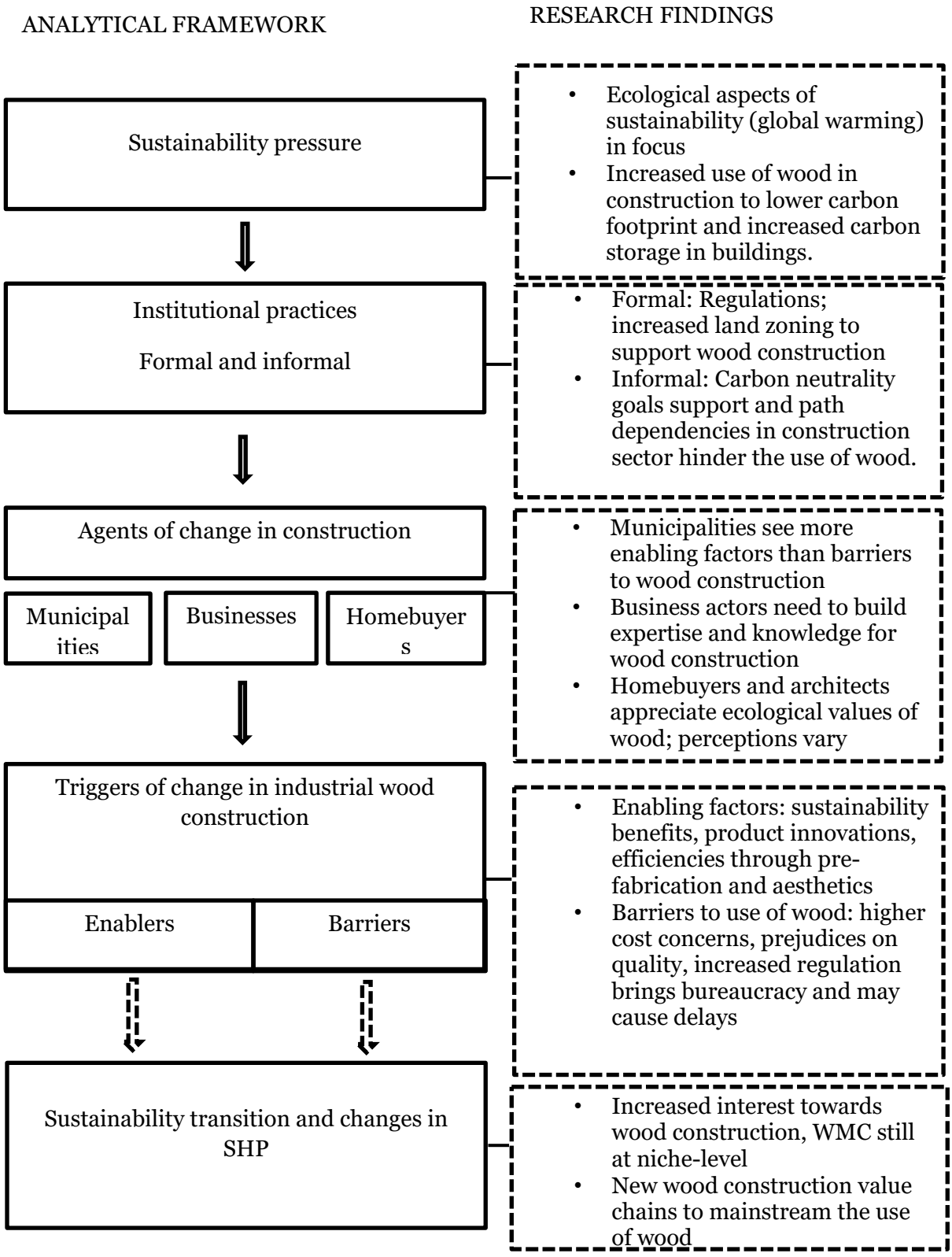

Figure 6. Summary of the research findings in relation to analytical framework of the dissertation.

6 CONCLUSIONS

The aim of this dissertation is to create a better understanding of factors enabling or hindering sustainability transition in construction sector and housing markets. This chapter discusses the main conclusions of the study related to theoretical contributions (Chapter 6.1) and managerial implications (Chapter 6.2), together with limitations and future research suggestions (Chapter 6.3).

6.1 Contributions of the thesis

To deal with the broad and complex problem of sustainability transition in construction sector, an analytical framework was introduced to guide the research. While the purpose of the framework is not to work as a step-by-step tool trying to explain or solve a specific problem, it merely aims to help the researcher and the reader structure a complex process to a more easily understandable, even overly simplified entity. The analytical framework introduced in the paper helps to achieve the research aim and the three research questions by positioning the Articles and addressing their connections. The framework may help develop further research on the subject.

Regarding scientific research on wood construction, this thesis first contributes by reviewing the literature on wooden multi-story construction enablers and barriers (especially in Article I) and suggesting future research streams from the findings. In reference to the SHP framework, the literature review highlighted a limited amount of research related to the exchange and consumption spheres, while acknowledging their importance when considering WMC market development. At the same time, the current research highlights pre-fabrication and sustainability in buildings as production sphere factors contributing to WMC market development. As concluded in the Article I, there seems to be momentum for the sustainability-driven forestry-wood construction value chains to challenge the dominant concrete-based regime through WMC. Research conducted in Article II further contributes to the understanding of institutional practices affecting building processes, while Article III contributes to the literature with a deeper understanding of the role of municipalities in enhancing sustainability development and their views on wood construction.

As a theoretical contribution (especially Article II), the study identified connections between institutional structures (Kadefors, 1995) and empirical building project phases, indicating the applicability of institutional approach in studying detached house building within the SHP system. However, theoretical development is needed to more transparently describe the roles of actors within

and between specific institutions. This illustrates how different actors, with their real-life practices, are positioned in the SHP system, also affecting the implementation and outcomes of building processes. In the Article II, a preliminary examination was made by positioning the results in the SHP framework. In a broader context and in future research, this approach might bring new avenues for analysing the obstacles and drivers of change in the housing markets. Based on the findings in Article II, most of the institutional practices causing delays were related to the production sphere of the SHP, highlighting the role of local-level governance actors. The results for public authorities indicate that formal institutions do not directly mean well-functioning institutional practices. Similar to the findings in Article I, the issues linked with the exchange sphere or consumption sphere of SHP were limited.

The study contributes to the knowledge gap identified in the literature review on the role of local-level governance actors as enablers of positive WMC market development, especially through Article III. First, the article provides a comprehensive description of municipalities' current activities related to sustainable construction and wood construction. Second, an analytic model is built in which municipalities are positioned as a nexus connecting different actors involved in the promotion of sustainable construction. The results highlight the key role of municipal decision makers in regulating public construction and their role as customers. This dual role grants municipalities the possibility of acting as gatekeepers (who scan and assess) or champions (who encourage innovation) in relation to industrial wood construction development.

6.2 Managerial implications

For municipal decision makers, this study provides several insights. First, in their role as customers in public construction, municipalities act as forerunners in the adoption of wood in construction. This is supported by the government setting goals to increase the use of wood in public construction. As many municipalities have already set goals to achieve carbon neutrality in the near future, it seems natural to support the use of wood as a renewable and locally supplied material during the transition while paying attention to the energy efficiency of the buildings. Municipalities may enhance industrial wood construction development through pilot projects and, for example, through public–private partnership projects. Furthermore, as discussed in Article III, supporting wood construction investments also supports local and regional businesses in the construction and forest sectors in many municipalities, especially in rural areas. Information

sharing through successful projects may help reduce the uncertainty and perceived risks faced by the construction industry.

Second, as institutional actors, the role of municipalities as regulators grants them great power, especially in the form of land zoning and land-use planning. While many municipalities have already adopted the efficient practice of zoning plots specifically for wood construction projects, others have been more reluctant to use this tool. Risks of exclusive land zoning also exist, and these can include limited competition (lack of available suppliers), resulting in higher construction costs. Extensive regulation may also cause delays in the construction processes, as discussed in the case of detached home construction in the Article I.

For businesses in the construction sector, it is fair to state that sustainability pressures affect all businesses and local governance actors. The current system of housing provision is undergoing transformation and provides both challenges; however, recognising the increasing sustainability expectations of residents and future customers may also bring new business opportunities. It is unclear what the future brings and which practices, construction methods and materials will be dominant. This research mainly considers the market potential of wood construction, which is currently seen as one solution to enhance sustainability through reduced greenhouse gas emissions in the construction sector. Construction companies are at the core of the transformation towards increased adoption of wood in the construction business ecosystem. Collaboration and information sharing among different stakeholders may enhance value co-creation and value capture opportunities for the whole business ecosystem (as also concluded by Toppinen et al., 2019b).

Path dependencies and lock-in effects have been blamed as the main hindering factors, together with cost concerns for industrial wood construction. Overcoming these obstacles requires change in how businesses operate. Industrial wood construction, especially in large buildings, is still relatively new, and while several construction companies are learning new skills, opportunities exist for those forerunner actors. This might also bring business opportunities to new actors in the wood construction industry and free many of the lock-in effects and traditions. The lack of awareness among consumers about benefits of industrial wood construction (e.g. sustainability benefits, aesthetics, usability and durability) should be recognised in the marketing efforts of construction businesses.

To make a change in the construction industry, WMC must also be viewed in the context of housing markets, not only through supply mechanisms mainly connected with technological benefits but also through cost-efficiency gains.

6.3 Limitations and future research suggestions

There are several choices made during the research that may be viewed as limitations of the study. In Chapter 6.3.1, my aim is to openly discuss and address the choices and limitations that were made during the study. After reviewing the research limitations, Chapter 6.3.2 is dedicated to briefly discuss future research suggestions based on the research gaps and results obtained during the study.

6.3.1 Limitations

First, related to the concept of institutional pressures in construction, the focus of the dissertation has been on sustainability challenges. While this helps to position the research and form the research aim and related questions, it may neglect some other important aspects affecting the development in the industry, such as globalisation, digitalisation or urbanisation. Furthermore, while sustainability consists of several aspects related to ecological, economic and social sustainability, the main focus has been on the ecological aspect. The research aims to study the adoption of wood in multi-story construction.

Second, the scope of the construction sector in this study has been limited to focusing on analysing residential construction, while non-residential buildings have been mostly neglected. Article I reviews literature on WMC, focusing on residential buildings. Article II analyses single-family homes and Article III concentrates on municipalities' views. While Article III touches on non-residential buildings as well, the markets for non-residential construction have not been fully addressed.

Third, the construction field consists of many different actors, as addressed in Chapter 1. While construction companies have a central role in the adoption of wood in construction, the empirical analysis and data for this dissertation have been collected from homebuyers and municipalities in Articles II and III, respectively. However, the role of construction companies has been emphasised in several earlier studies, as noted in the literature review of Article I. This helped to make the choice and frame the study in a way that covers other important actors, creating better prospects to contribute to scientific research in the field.

6.3.2 Future research suggestions

So far, the focus of research on WMC apartments has mostly been on their supply (i.e. production sphere) in the housing markets, while consumer expectations for

WMC homes have gained considerably less attention. The same applies to the exchange sphere of the SHP (e.g. role of intermediaries). In particular, the attitude of investors and finance institutions towards wood construction and their role in sustainability transformation is interesting. Research on municipal decision-making and land zoning and intermediaries involved in the housing markets is still limited (with exceptions of e.g. Franzini et al., 2018; Vihemäki et al., 2020; Lindblad, 2020).

While increased interest in wood construction and demand pressure is expected from changes in consumer needs and expectations, more research (or time) is needed to understand how these will occur. As concluded in the literature review, limited knowledge on consumer behaviour and on the experiences of living in wooden multi-storey buildings is currently available (with the exception of Viholainen et al., 2021b). Comparing data that covers other building materials in addition to wood buildings would help to understand the importance of sustainable development for consumer choices. Acknowledgment of the versatile needs of end users – for example, in terms of modularity of housing and flexibility in terms of changing uses over building life span – is still needed.

More in-depth information is needed on WMC market development in the form of longitudinal research focusing, for example, on collaboration with actors in the construction value chains and emerging business ecosystems (e.g. actors related to exchange and consumption spheres in the system of housing provision). More information is also needed on how a more open innovation culture between different actors could be enhanced to broaden the collaboration networks for value co-creation and the accumulation of new skills. A need to better understand the factors enabling the formation of such forms of collaboration exists, which would better enable sharing the risks in WMC projects, since this topic was hardly touched upon in the study.

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Wooden multi-storey construction market development – systematic literature review within a global scope with insights on the Nordic region

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Highlights

- Enabling factors for WMC market diffusion include benefits from cost-efficiency gains from prefabrication and industrialization and perceived sustainability benefits.
- Inexperience of using wood, and path dependencies to use concrete and steel in multi-storey building are the key barriers for mainstreaming WMC market development.
- More research is needed on the development in the wood construction value-chains to challenge the dominant concrete-based construction regime in the housing markets.

Abstract

Climate change sets high pressures on the construction industry to decrease greenhouse gas emissions. Due to the carbon storage properties and potential to use renewable resources efficiently, wooden multi-storey construction (WMC) is an interesting alternative for the construction industry to enhance sustainable development combined with the aesthetic and well-being benefits of wood perceived among many consumers. For forest industry firms, industrial wood construction is a possibility to seek for business opportunities and bring socio-economic benefits for local economies. Despite positive drivers, WMC still remains a niche even in the forest-rich countries.The purpose of our study is to add understanding on the WMC market development by conducting a systematic literature analysis on international peer-reviewed studies from the past 20 years. Our special focus is on the role of WMC in the housing markets studied from the perspectives of the demand, supply and local governance factors. As specific aims, we 1) synthesize the key barriers and enabling factors for the WMC market growth; 2) identify the actors addressed in the existing studies connected to the WMC market development, and 3) summarize research methods and analytical approaches used in the previous studies. As a systematic method to make literature searches in Web of Science and Scopus for years 2000–2020, we employed PRISMA guidelines. By using pre-determined keywords, our searches resulted in a sample of 696 articles, of which 42 full articles were after selection procedure included in-depth content analysis. Our results showed cost-efficiency gains from industrialized prefabrication and perceived sustainability benefits by consumers and architects enabled a WMC market diffusion. The lack of experiences on the WMC, and path dependencies to use concrete and steel continue to be key barriers for increased WMC. Although our research scope was the global WMC market development, most of the literature concerned the Nordic region. The key actors covered in the literature were businesses (e.g., contractors, manufacturers and architects) involved in the wood construction value-chains, while residents and actors in the local governance were seldomly addressed. Currently, case stud-

ies, the use of qualitative data sets and focus on the Nordic region dominate the literature. This hinders the generalizability of findings in different regional contexts. In the future, more research is needed on how sustainability-driven wood construction value-chains are successfully shaping up in different geographical regions, and how they could challenge the dominant concrete-based construction regime.

Keywords construction industry; consumer; forest-wood value-chain; municipality; sustainability; urbanization
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1 Introduction

Climate change, as the most pressing global problem facing humanity, calls for a sustainable change towards adoption of low-carbon solutions in the emission intensive construction industry, for example, in relation to UN Sustainable Development Goals (SDGs) (Ogunmakinde et al. 2022). Since wood is a renewable material with relatively low embodied fossil carbon, timber structures have beneficial climate impacts compared to other construction materials (Geng et al. 2017; Hafner and Schäfer 2017; Hildebrand et al. 2017; Peñaloza et al. 2016). Building with wood has strong traditions all over the world, and prefabrication of modules is broadly used in the detached housing sector (DeAraujo 2021; Jussila and Lähtinen 2020). Contrastingly, wooden multi-storey construction (WMC) is still in the niche also in the forest-rich regions, although it has strong potential to enhance sustainability in urban housing and development of circular bioeconomy in cities (Toppinen et al. 2019a; Lähtinen et al. 2021).

Prefabrication and industrialization of the building processes has been emphasized in the construction industry especially in the 2000s (Jonsson and Rudberg 2014). At the same time, engineered wood products have entered in the markets to substitute concrete and steel, for example, in the load-bearing structures of multi-storey buildings (Schuler et al. 2001; Tettey et al. 2019). The rise of engineered wood products combined with updated building codes on fire protection have enabled the recent increase in wood use in Europe and building taller wooden buildings than before (Hildebrandt et al. 2017). This growing interest towards WMC may also be attributed to low costs, rapid construction phase, and perceived aesthetic and natural qualities of wood (Gold and Rubik 2009; Gosselin et al. 2017; Viholainen et al. 2021b).

Adoption of WMC technologies has gradually advanced through technical innovations (Lindgren 2017; Lazarevic et al. 2020). As previous research and experience from various countries indicate, the established modes of operating in multi-storey construction favor concrete as the framing material due to path-dependencies (e.g., established standards, regulation, construction culture) (Kadefors 1995; Hemström et al. 2017; Mark-Herbert et al. 2019). These path dependencies derived from the concrete-based industries have caused lock-ins, such as reliance on the existing traditions in the implementation of business models and management of risks that have slowed down the uptake of industrial wood building technologies (Nordin et al. 2010; Riala and Ilola 2014; Vihemäki et al. 2019). Yet, as construction is usually a domestic field of business and significantly affected by local governance, considerable variations may occur in the pace of WMC market development within individual countries (Hemström et al. 2017; Lähtinen et al. 2019a; Vihemäki et al. 2019).

The expectations for the market diffusion of the WMC in the context of housing markets relates to the global urbanization development (Dangel 2017). At the same time, societal pressures increase the need to develop and scale up building solutions that can better respond to social, economic and environmental sustainability goals, including the global climate change challenge (Lindblad and Schaurte 2017; Mark-Herbert et al. 2019; Vihemäki et al. 2019). For example, through linkages with the UN Sustainable Development goals (in particular SDG11 (Sustainable cities and communities), SDG12 (Responsible consumption) and SDG13 (Climate action) (https://sdgs.un.org/goals), construction industry and housing markets are linked with global policies and actions (Wolf et al. 2017).

Over time, customers, industries and other actors can co-create both user value and thereby promote the development of climate neutral municipalities (Edmondson 2018), provided that changes in legislation, political programs and education will effectively enhance the use of wood in multi-story construction (Toppinen et al. 2019a). For example, through collaboration, business actors (e.g., construction industries) and customers (e.g., future residents) can enhance knowledge accumulation and development of building processes for value increase and desirability of WMC (Lähtinen et al. 2022). Similarly, actors responsible for local governance mechanisms in municipalities can support uptake of building solutions with environmental benefits (Lähtinen et al. 2019a).

Overall, regarding the future market development, the prospects for WMC appear positive, based on the technological development of engineered wood products, modular building solutions, and increasing interest among professionals (architects, engineers and planners) all around the world (Dangel 2017). In addition, for example in the Nordic region, owner-occupancy plays an important role in the housing markets either in the form of owning a detached house or, owning a share of a housing company or being a member of a housing co-operative (Andersson et al. 2007). Due to this, residents' perceptions and value orientations on the role of sustainability, including the expected climate benefits, is critical for the market share development of WMC (Lähtinen et al. 2021). Abreast with the need to increase value in housing through communication with future residents, for example, on the load-bearing material choices in multi-storey construction (Lähtinen et al. 2022), consumers may also contribute to the fulfillment of sustainable construction initiatives during the life-cycles of the buildings (Ogumankinde et al. 2022). In addition, from the perspective of fulfillment of sustainable urbanization aims, e.g., SDG11, knowledge on demand factors in the housing markets is important (Wolff et al. 2017). In parallel, the potential of the WMC industry to produce solutions meeting these user expectations and criteria is fundamental for unlocking the growth potential of this niche field of construction (Toppinen et al. 2018).

A number of studies have been introduced in recent years addressing factors influencing the emergence of WMC (Gosselin et al. 2017; Hemström et al. 2017; Hurmekoski et al. 2018). Yet, the state of the art in the literature as a whole remains largely unmapped. The few existing systematic reviews have focused on the literature regarding sustainability in the residential construction in general (Lima et al. 2021). In those studies, it has been found out that social and economic aspects are less frequently addressed in comparison to environmental sustainability, and that wood material appears as a small but central node in the research from building materials perspective. However, evidence exist that, for example, in interior use wood connects with perceived psychologic human well-being effects (Rice et al. 2006; Nyrud and Bringlinsmark 2010). Other reviews like de Carvalho et al. (2017) have mapped integration of lean technology over a building's life-cycle without including aspects arising from the usage of renewable building materials, nor the ones connected to social science perspectives.

Considering the positive growth prospects in WMC market, there is a need to better understand how businesses involved in WMC are developing their strategies towards sustainability and

municipal carbon neutrality goals. In addition, information is needed how these connect to end-user needs, and how the actors can better engage in these processes with other actors, in particular with local municipalities. Better knowledge on these matters and about the roles of key actors, will enable WMC businesses to craft localized and collaborative strategies that would result in better value creation.

The interplay of producers, consumers, and regulators is also a key theme for this study, as the markets with unclear growth prospects often face a chicken-egg problem of producers having to invest in new production capacity without prospective customers, and consumers not being able to buy apartments when there is no supply. Related to that, little is known about how key actors in local wood construction – customers, local policymakers and builders – jointly contribute to sustainable construction and increased user value. Elements hereof involve sustainability and climate considerations (i.e., carbon stock and substitution effects) in the consumers' decision making.

This paper thus aims to delimit the knowledge-gap by synthesizing the current scientific literature on the factors related to WMC demand, supply and local-level governance that affect the circumstances in the housing markets. As a result of our analysis, we summarize and conceptualize the challenges of WMC market development and identify aspects, which requires to be addressed in future studies to establish new research agenda, as called by Zhang et al. (2019).

The first aim of our study is to synthesize the key barriers and enabling factors for the WMC market growth addressed in international peer-reviewed studies in 2000–2020. As the second aim, we identify the actors, who have been addressed in this literature to have a key role to affect the WMC market development. Third, we synthesize the types of research methods and analytical approaches used to study the themes related to the WMC market development and actor roles. Finally, based on the results, we present implications for future research needs. The past 20 years have been characterized both by the increasing emphasis in the construction industry for industrialization (Jonsson and Rudberg 2014) and development of wood-based solutions to substitute concrete and other fossil-based building materials also in multi-storey buildings (Schuler et al. 2001). Thus, by evaluating the state of the art in the WMC literature published in that period, we contribute to the understanding of dynamics of systemic change in the construction industry towards more sustainable practices in the housing markets. By doing this, we will gain not only an improved scientific understanding on the state of the art, and the related gaps in the knowledge, but the study will also will contribute with new insights how WMC industry could be revitalized or become more sustainable and competitive. The study is mainly focusing on market behavior, interaction and strategies by WMC actors. It does not explore in depth roles of international and national policies. This is a separate issue that merits a study on its own.

2 Analytical framework of the study to assess the potential for WMC market development

In the construction industry business environment and housing markets, socio-economic changes (e.g., increase of income and wealth) have diversified consumer demand (Gibler and Tyvimaa 2014). As a result of this, but also due to the need to enhance the efficiency and sustainability of the construction industry, expectations towards the businesses and other actors acting as suppliers of homes to make changes in their dominating practices have increased (ONeill and Gibbs 2014; Jussila and Lähtinen 2020). Changing sustainability practices do not only relate to businesses, but also concern needs and views of other stakeholders (e.g., authorities, consumers), who are involved in building processes or use of buildings (Ogunmakinde et al. 2022).

These needs for business changes do not concern specifically WMC, but all types of building processes in the global construction industry markets (Holt 2013; Jonsson and Rudberg 2014). For example, abreast with the need for more sustainable and resource-efficient use of materials, business development through evolvement of business ecosystems has been emphasized to bring new opportunities for the construction industry (Pulkka et al. 2016). As a result, it has been shown that positive impacts on value creation can be achieved through deepening collaboration, which extends beyond traditional transaction-based project-level subcontracting (Toppinen et al. 2019b). In the business ecosystems, actors involved in production, exchange and consumption spheres connect with each other, for example, through communication that enhances possibilities for value co-creation (Pulkka et al. 2016, Toppinen et al. 2019b).

For WMC, communication between companies, local governance actors (e.g., urban planners) and future residents within business ecosystems may enhance accumulation of know-how, which supports future business development possibilities (Toppinen et al. 2019b; Lähtinen 2022). In addition, communication with actors enables the sector to overcome prejudices against building with wood connecting, for example, deficiencies in the knowledge on fire safety and technological durability of wooden materials in multi-storey houses (e.g., load-bearing structures) (Lähtinen et al. 2021).

Production, consumption and exchange patterns in the housing markets may be illustrated with Structures of Housing Provision (SHP) framework (Ball and Harloe 1992; Ball 1998; Burke and Hulse 2010) (Fig. 1). According to SHP, supply and demand in the housing markets are dependent on geographic circumstances at specific points of time reflecting in spheres of consumption, production and exchange. In the context of Nordic countries, for example, traditions in building with wood and home ownership structures affect how especially WMC housing markets evolve (Lähtinen et al. 2021). In relation to sustainable urbanization and fulfillment of the UN Sustainable Development Goals, knowledge on housing markets as a system is needed instead of focusing merely on technological aspects of products and processes (Wolff et al. 2017).

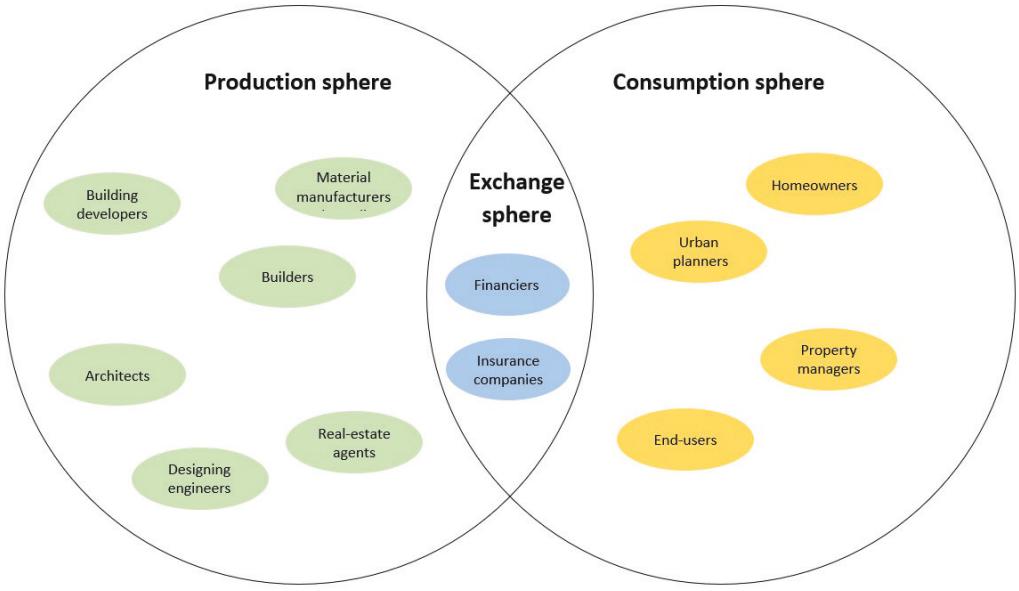

Fig. 1. Actors connected to structures of housing provision (SHP) with potential to affect WMC market development.

The consumer sphere describes housing values, which are reflected in consumer preferences and processes to rent, purchase and choose homes. In the context of WMC, those preferences and processes are connected with path dependencies, for example, in the ownership structures in the housing stock in specific regions and perceptions of consumers, for example, on WMC (Lähtinen et al. 2022). In comparison, supply structures in production sphere comprise business choices and capabilities of businesses involved in the construction value-chains (e.g., suppliers of building solutions) (Stehn et al. 2002), and decisions of public authorities to zone land for building and give associated regulations (Lähtinen et al. 2019a).

Abreast with companies involved in WMC value-chains and consumers renting or purchasing homes, local, municipal authorities have an impact on the development of WMC markets, and the achievement of sustainable urbanization goals. For instance, land zoning decisions and practices to grant building permits within municipalities (Lähtinen et al. 2019b; Jussila and Lähtinen 2020) affect the possibilities of companies to develop neighborhoods that can be perceived as attractive ones among residents. In line with this, local cultures to work with specific building material traditions can play a decisive role in WMC market development (Høibø et al. 2015, 2018). In the Nordic countries, especially in Finland and Sweden, municipalities have strong power in the land use governance (Mäntysalo et al. 2011), and thus their governance mechanisms are key for the prospects of wood construction.

Finally, abreast with businesses and public actors (e.g., municipalities) operating in production sphere and consumers in consumption sphere, financial institutions governing monetary instruments belong to the system of housing markets. In the context of the SHP framework, they operate in exchange sphere, that enable renting, selling and use of homes in the markets through governance of monetary instruments (Ball 2003; Burke and Hulse 2010). In practice, as funders of actors in production and consumption spheres, actors in exchange sphere enable both implementation of operations in the housing markets (e.g., building and purchasing homes), but also managing of different types of risks through assignment of insurances.

According to SHP, housing markets are a system of actors, who in multiple ways are connected to each other (Burke 2012). By evaluating WMC market development through SHP spheres, it is possible to gain a comprehensive understanding of how different actors (e.g., home purchasers and renters, building developers and builders, public authorities and urban planners) affect the potential for sustainable urbanization in reference to housing market mechanisms. Furthermore, employment of SHP also enables identifying how other actors (e.g., interest organizations, non-governmental organizations, research institutions and universities, politicians, or legislators) also belonging to the WMC business ecosystems (Lähtinen et al. 2022) have been addressed in previous studies on WMC. The analytical framework of our study to identify the enabling factors and barriers for WMC market development in relation to production, consumption and exchange spheres, and the actors involved are presented in Fig. 1.

3 Materials and methods

The data of the study are based on international peer-reviewed studies (herewith referred as peer-reviewed articles) published in 2000–2020. Searches were carried out in two databases (Scopus and Web of Science) by using predetermined search words for titles, abstracts, and keywords. The predetermined keywords were defined based on existing information received from literature employed, for example, in the empirical background of this study. Prior to implementation of the literature searches, the applicability and formulation of the keywords (e.g., use of hyphens, compound words) were tested by the research group members in three consecutive workshops. This

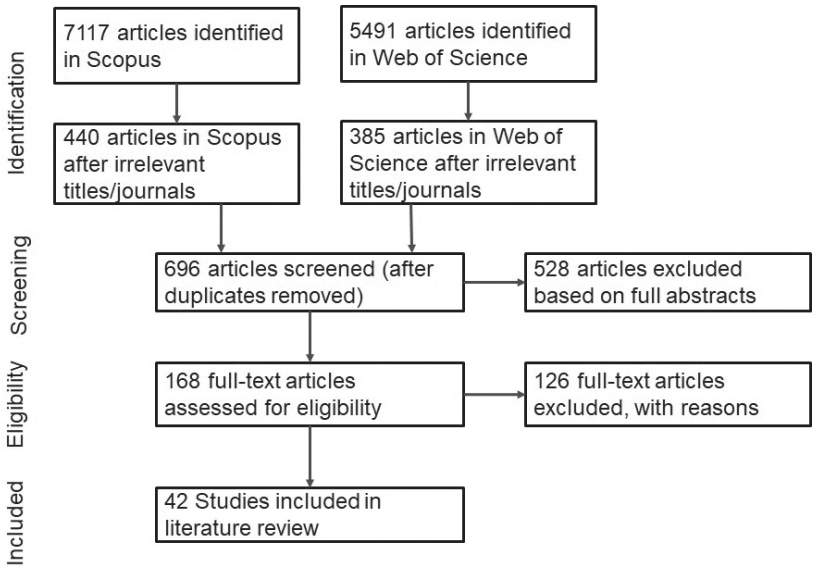

Fig. 2. Literature review process applied in the study (see PRISMA-method, e.g., Moher et al. 2019).

was done to enhance the validity (i.e., no exclusion of relevant literature, exclusion of literature entirely from different fields of research) of the material to be found.

As a method of analysis, a systematic literature approach was employed, since it is a transparent, rigorous, and detailed methodology used to support decision making (Tranfield et al. 2003). The method may also be used to build theory by accumulating knowledge and evidence after analyzing large number of studies and methods, thereby increasing the consistency of the results and the conclusions (Akobeng, 2005; Denicol et al. 2020). This study follows the PRISMA guidelines by Moher et al. (2009), and our systematic literature review was performed in four stages (Fig. 2). Details of the initial search phrases, methods and exclusion criteria are shown in Supplementary file S1, available at https://doi.org/10.14214/sf.10609.

The first phase of the literature review process comprised general identification of the literature. As an outcome of the database searches executed at the identification phase, 7117 document results were received in Scopus and 5491 in Web of Science, respectively. After exclusion of irrelevant journals and titles, a total number of 825 peer-reviewed articles remained for further screening (440 in Scopus and 385 in Web of Science). At this phase also duplicates were removed from the search results, which resulted in a total number of 696 peer-reviewed articles.

The second phase of the literature review was composed of screening of the 696 articles conducted by the research team as a case-by-case evaluation. In this phase, a total of 528 articles were excluded based on full abstract reading using preliminary addressed exclusion criteria. The list of excluded studies consisted of peer-reviewed articles, which were not addressing wood construction or had strictly technical focus (i.e., no information to add knowledge on WMC market development). After the screening phase, altogether 168 studies were left for further consideration at the eligibility phase.

The third phase, i.e., eligibility assessment, included full-text reading of the 168 peer-reviewed articles. In the beginning of the eligibility assessment phase, each article was read independently by two researchers. After this, the research group members discussed the evaluation results together to strengthen the validity of the results. As an outcome of the eligibility assessment phase, a total number of 126 peer-reviewed articles were excluded from further reading.

The excluded studies were not addressing multi-storey buildings, were not focusing on the market development perspectives, or were focusing on other types of houses than residential buildings. In addition, some peer-reviewed articles were excluded due to their unavailability in an electronic format. Furthermore, a few articles were found to be published in non-peer-reviewed journals and therefore excluded. After the eligibility assessment, a total number of 42 peer-reviewed articles were included in the initial material of this study.

As the final phase of the literature review, all 42 peer-reviewed articles were analyzed in depth. The first focus of this stage of the analysis was to categorize the contents of the materials into the themes of enabling factors and barriers, which affect the potential for WMC market development. As an analytical framework to link the results with the housing markets, SHP framework was employed. The categorization process also included identification of the key actors, who had been addressed in the peer-reviewed articles as parties with some kinds of roles in the WMC market development. At this phase, also the research methods and analytical approaches used in the 42 studies were evaluated to add knowledge on by what approaches the WMC market demand development had been addressed in the previous studies. By doing this, it was possible to add, for example, understanding on what types of methodological and analytical development would be needed in the academic research to provide new information on the WMC in the context of housing markets in the future.

4 Results

The general outcome of the analysis shows that the number of published peer-reviewed articles on WMC has increased especially after 2017 (Fig. 3). This is an indication of an increasing interest among scholars on the WMC especially in the recent past. Yet, although literature searches comprised studies published since the early 2000s, all 42 studies passing the final eligibility assessment in the review process were released after 2006 (Fig. 3). This shows that despite the WMC has been

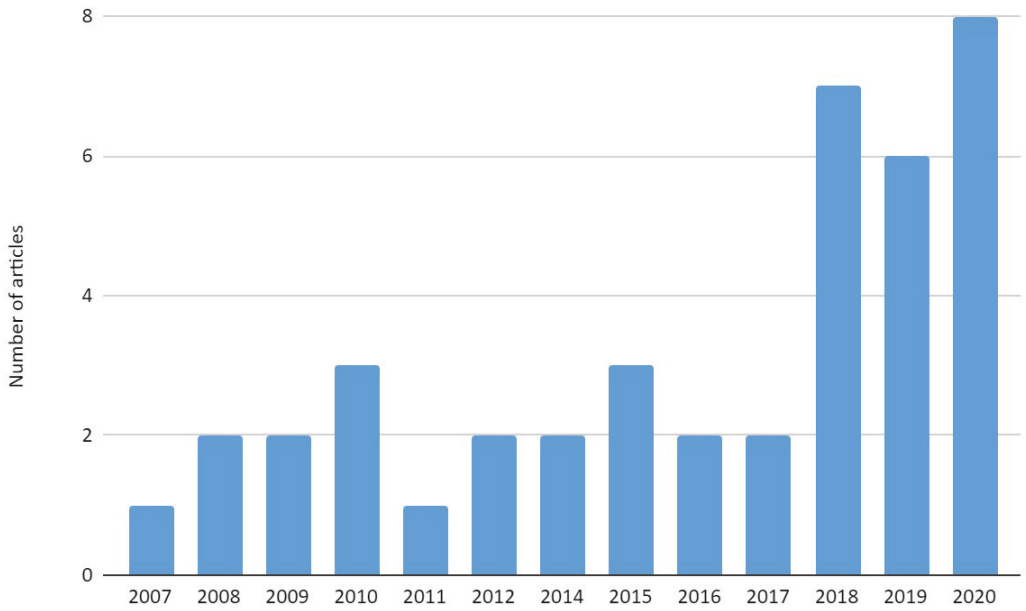

Fig. 3. Studies included in the literature review by publication year (total of 42 articles).

studied from different perspectives rather actively in the recent years, aspects connected to WMC market development in relation to views on demand, supply and local governance have gained much less attention among academics. This can also be perceived, for example, by comparing the number of publications found at the identification phase of the literature searches with the number of studies fulfilling the initial search criteria (Fig. 2).

The distribution of studies composing the final data of the study were published in 27 different journals, of which the most common ones were Wood Material Science and Engineering (5 studies, especially a special issue in 2019), Journal of Cleaner Production (4 studies) and Construction Management and Economics (4 studies). Regarding the geographical focus of the studies, the results of this study indicate that WMC market development research has been dominated by studies connected to the Nordic region. The empirical data in the final set of articles concerned Nordic countries (Finland, Sweden or Norway) in 37 out of 42 articles, while 8 articles covered also other geographical areas (e.g., US, UK and Central Europe).

In reference to SHP framework, our analysis showed that information in the literature addressed solely views linked with production and consumption spheres (Table 1). Contrastingly, no information related to exchange sphere existed in the 42 peer-reviewed articles employed as the material of this study, although, for example, financing significantly contributes to functionality of the housing market (Österling 2017; Jussila and Lähtinen 2020). Naturally, there are a myriad of policy drivers that are underlying the SHP framework although these could not be under our direct scrutiny, and some of the reviewed studies also addressed these (such as Tykkä et al. 2010, Hurmekoski et al. 2018, or Vihemäki et al. 2019).

As result of the categorization process to identify the themes affecting as enablers and/or barriers for the WMC market diffusion, eight general themes emerged in our literature review analysis. The eight themes were named as Sustainability in building, System development, Innovations, Business collaboration, Stakeholder awareness, Institutional changes, Urban planning, and Market demand. In all, Table 1 shows that the reviewed literature provided more nuanced understanding on production sphere enablers and barriers, while the availability of information on consumption sphere was considerably scarcer.

According to the detailed results on the enabling factors for WMC market development illustrated in Table 2, information on the possibilities was found for all other themes than Market demand. In general, aspects related to themes on the Sustainability in building, System development, Innovations, Stakeholder awareness, and Institutional changes was found to a higher extent than aspects on themes on Business collaboration and Urban planning. Business collaboration and Urban planning both relate to business ecosystems (Pulkka et al 2016), while the lack of information on the Market demand significantly shows the deficiencies linking the WMC with the broader housing market context (Burke and Hulse 2010).

Business ecosystems may significantly contribute to the construction industry development. Despite this, in the reviewed literature there were just few peer-reviewed articles addressing WMC market development through views on business collaboration. Related to this, also profound information on how different actors might contribute to WMC market development was largely lacking. In all, most of the studies addressed mainly element manufacturers, engineers, and construction companies as key actors in the WMC system. Yet, for instance, municipalities (e.g., urban planners and other civil servants) may contribute to WMC market development through their land zoning activities and accumulation of local know-how through their collaboration with local industries. Similarly, also future residents could add possibilities for the value co-creation in production sphere through their communication activities in the business ecosystems.

Table 3 shows the barriers, which in relation to production sphere were found to hinder WMC market development. As a difference to enabling factors, Sustainability in building was

Table 1. Categorization of the literature for themes of enablers (E) and barriers (B) for the WMC market development in connection production and consumption spheres within structures of housing provision.

		Production sphere							Consumption sphere						
Authors	Year	Sustain-ability in building	System develop-ment	Innova-tions	Business collabora-tion	Stake-holder awareness	Institu-tional changes	Urban planning	Market demand	Sustaina-bility in building	System develop-ment	Innova-tions	Business collabora-tion	Stake-holder awareness	Institu-tional changes	Urban planning	Market demand
Stehn and Bergström	2002		E/B														
Björnfot and Stehn	2007		E														
Sandberg et al.	2008		E	B													
Mahapatra and Gustavsson	2008		E/B		E	E	E										
Persson et al.	2009		E	B													
Bysheim and Nyrud	2009		B			E											
Tykkä et al.	2010	E	B	E			E										
Nordin et al.	2010		B	E													
Roos et al.	2010	E	E/B			B											
Hemström, et al.	2011	E	B				B		B								
Eriksson et al.	2012	E															
Mahapatra et al.	2012		E/B			E/B	E			E/B							
Brege et al.	2014		E	E					B								B
Riala and Ilola	2014		E/B	E		B											
Mallo and Espinoza	2015	E	B			B	B										
Hurmekoski et al.	2015		E/B			E/B	E/B										
Høibø et al.	2015									E				B		B	
Jones et al.	2016		B	E		E											
Hynynen	2016	E	B	E	B		E										B
Lindgren and Emmitt	2017	E	E	B			E										
Hemström et al.	2017		B			E											
Høibø et al.	2018															B	
Stern et al.	2018					E								B			
Gosselin et al.	2018		E/B	E	E	E	B										
Hurmekoski et al.	2018		B				E										
Franzini et al.	2018		E/B		B	B	B	E									
Toppinen et al.	2018						E							B			
Markström et al.	2018	E	E			E/B											
Toppinen et al.	2019				E/B												

Table 1 continued.

Authors	Year	Production sphere								Consumption sphere							
		Sustain-ability in building	System develop-ment	Innova-tions	Business collabora-tion	Stake-holder awareness	Institu-tional changes	Urban planning	Market demand	Sustaina-bility in building	System develop-ment	Innova-tions	Business collabora-tion	Stake-holder awareness	Institu-tional changes	Urban planning	Market demand
Lähtinen et al.	2019									E				B			
Vihemäki et al.	2019						E/B										
Lindblad	2019							B									
Toppinen et al.	2019				E/B	E											
Markström et al.	2019	E	E		B	E/B	E										
Riggio et al.	2020		B	E	E/B	B											
Pelli and Lähtinen	2020		E	B													
Peters et al.	2020		E	E		E	E										
Kylkilahti et al.	2020									E				E			
Viholainen et al.	2020									E/B							
Lindblad	2020							E/B									
Vihemäki et al.	2020				B	E	B										
Lazarevic et al.	2020		B				E/B										

Table 2. Categorization of the themes of enabling factors for the WMC market development in connection to production sphere within structures of housing provision.

Themes of production sphere enablers	Key role actors	Literature
Sustainability in building		
Low environmental impact; Aesthetic appeal; Carbon storage; Structural durability	Architects; Element manufacturers	Hynynen 2016; Hemstrom et al 2011; Mallo and Espinoza 2015; Roos et al. 2010; Markstrom et al. 2018; Markström et al. 2019; Tykkä et al. 2010; Lindgren and Emmitt 2017
System development		
Standardization; Industrialized production, Productivity; Technological development (e.g., IT tools); Low costs; Flexibility; Rapid construction	Construction companies; Element manufacturers	Sandberg et al.2008; Björnfot and Stehn 2007; Brege et al. 2014; Pelli and Lähtinen 2020; Peters et al. 2020; Stehn and Bergström 2002; Gosselin et al. 2018; Hurmekoski et al. 2015; Mahapatra amd Gustavsson 2008; Riala and Ilola 2014; Mahapatra et al. 2012; Roos et al. 2010; Markstrom et al. 2018; Markström et al. 2019; Tykkä et al. 2010; Persson et al. 2009; Franzini et al. 2018
Innovations		
New construction technologies; Prefabrication; Product innovations (e.g. CLT); System innovation (e.g. collaboration and integration of new solutions); Research collaboration	Construction companies; Engineers	Hynynen 2016; Riggio et al. 2020; Peters et al. 2020; Jones et al. 2018; Gosselin et al.2018; Nordin et al. 2010; Riala and Ilola 2014; Tykkä et al. 2010; Brege et al. 2014
Business collaboration		
Collaboration and co-operation between stakeholders; Communication and relationships in network	Product manufacturers; Engineers; Architects	Riggio et al. 2020; Gosselin et al. 2018; Toppinen et al. 2019a; Toppinen et al. 2019b
Stakeholder awareness		
High level of awareness of wood building systems and construction materials; Positive knowledge and experiences on use of wood; Promotional activities; Role of intermediaries; Resonance; Education and vocational training; Sustainability aspects (e.g., for marketing and branding)	Construction companies; Other stakeholders	Peters et al. 2020; Stern et al. 2018; Jones et al. 2018; Gosselin et al. 2018; Hurmekoski et al. 2015; Vihemäki et al. 2020; Bysheim and Nyrud 2009; Mahapatra et al. 2012; Hemström et al. 2017; Markström et al. 2019; Toppinen et al. 2019b
Institutional changes		
Policy measures and institutional frameworks; Law and regulation changes (e.g., Fire regulations, building regulations); Changes in building codes; Governmental support programs	Policymakers; Product manufacturers	Hynynen 2016; Peters et al. 2020; Hurmekoski et al. 2015; Hurmekoski et al. 2018; Vihemäki et al. 2019; Toppinen et al. 2018; Mahapatra et al. 2012; Tykkä et al. 2010; Lazarevic et al. 2020
Urban planning		
Improved transparency in the land allocation activity; Supporting local industries; Using locally sourced materials	Building developers; Municipal decision makers	Lindblad 2020; Franzini et al. 2018

Table 3. Categorization of the themes of barriers for WMC market development in production sphere within structures of housing provision.

Themes of production sphere barriers	Key role actors	Literature
System development		
Lock in effects: Path dependency (e.g., in concrete); Risk avoidance; High costs; Material availability; Lack of experience & education; Technical focus on construction	Construction companies; Architects	Jones et al. 2016: Mahapatra K., Gustavsson L. 2008; Hemström et al. 2017; Lazarevic et al. 2020; Nordin et al. 2010; Riala and Ilola 2014; Hurmekoski et al. 2018; Bysheim and Nyrud 2009; Tykkä et al. 2010; Mahapatra et al. 2012; Riggio et al. 2020; Mallo and Espinoza 2015; Hemström et al. 2011; Roos et al. 2010; Gosselin et al. 2018; Hurmekoski et al. 2015; Franzini et al. 2018; Hynynen 2016; Stehn et al. 2002
Innovations		
Inability to adapt changes; Recognition and tradition; Lack of requisites for efficient information management skills	Wood element manufacturers; Developers	Pelli and Lähtinen 2020; Lindgren and Emmitt 2017; Persson et al. 2009; Sandberg et al. 2008
Business collaboration		
Competitiveness of WMC (especially technical infrastructure); Multi-party environment, loose-couplings (lack of stable partnerships & collaboration); Limited number of industry actors; Mismatch in influence and material preferences among stakeholders; Conflict of interest; Lack of collaboration / co-operation; Fierce competition	Developers; Project actors; Other stakeholders	Toppinen et al. 2019a; Riggio et al. 2020; Franzini et al. 2018; Markström et al. 2019; Toppinen et al. 2019b; Hynynen 2016
Stakeholder awareness		
Lack of knowledge & information; Negative perceptions of product features (e.g., Fire performance, water control, durability concerns); Inadequate information distribution; Negative experience of wood products	Architects; Engineers; Construction companies; Municipal civil servants	Riala and Ilola 2014; Mahapatra et al. 2012; Riggio et al. 2020; Mallo and Espinoza 2015; Roos et al. 2010; Markström et al. 2018; Franzini et al. 2018; Markström et al. 2019
Institutional changes		
Institutional framework, lock-ins; Inefficient policy measures & processes; Building code compatibility	Municipal civil servants; Architects; Wooden building material producers	Lazarevic et al. 2020; Mallo and Espinoza 2015; Hemström et al. 2011; Gosselin et al. 2018; Vihemäki et al. 2020; Vihemäki et al. 2019; Franzini et al. 2018
Urban planning		
Discrepancies in perception of the land allocation process; Insufficient procurement processes for municipalities; Level of competence displayed by municipalities	Municipalities; Developers	Lindblad 2020; Lindblad 2021
Market demand		
Immature market, lack of pull effect, lack of consumer demand	Element manufacturers; Architects; Consumers	Brege et al. 2014; Hemström et al. 2011

Table 4. Categorization of the themes of enabling factors for WMC market development in connection with consumption sphere within structures of housing provision.

Themes of consumption sphere enablers	Key role actors	Literature
Sustainability in building		
Ecological, environmental values, natural material; Technical sustainability (e.g., usability and durability); Social sustainability (e.g., healthy, comfort, aesthetic)	Consumers, End users	Lähtinen et al. 2019b; Viholainen et al. 2020; Kylkilahti et al. 2020; Mahapatra et al. 2012; Høibø et al. 2015
Stakeholder awareness		
Ecological awareness	Consumers, End users	Kylkilahti et al. 2020

not addressed in any of the reviewed studies as a theme, which would comprise obstacles for the WMC. Instead, the barriers were identified in relation to all other seven themes, of which most were connected to System development (e.g., lack of knowledge and information, limited experience with building with wood) and Stakeholder awareness (e.g., negative perceptions of product features such as fire safety, water control, durability), and Business collaboration (e.g., lack of collaboration, lack of stable relationships). In addition, for example, in relation to Urban planning, discrepancies in actor perception of the land allocation process and deficiencies municipality capacities for public procurement processes were mentioned in the literature. Especially from the perspective of research on WMC market development potential it is worth of noticing that while information on the barriers were found for Market demand, such enablers were not addressed in the reviewed literature at all.

Compared to production sphere, information connected to consumption sphere especially on the enabling factors was almost non-existent in the reviewed literature. Like shown in Table 4, findings made on the enabling factors did not address any other themes than Sustainability in building, which were linked with views on ecological, technical and social sustainability benefits of wooden multi-storey houses. All other information on the potential of any other themes (e.g., Business collaboration, Stakeholder awareness) to affect positively WMC market development through consumption sphere was entirely lacking. In reference to issues arisen in the literature presented in the context of the analytical framework of this study, the gaps in information concerned, for example, insights on the possibilities of future residents to enhance value creation possibilities

Table 5. Categorization of the themes of barriers for WMC market development in connection with consumption sphere within structures of housing provision.

Themes of consumption sphere barriers	Key role actors	Literature
Sustainability in building		
Product features: Durability, robustness, stability, fire safety, acoustics; Higher maintenance; Resale value (UK)	Consumers; End users	Viholainen et al. 2020; Mahapatra et al. 2012
Stakeholder awareness		
Lack of awareness among end users; Prejudice against wood (material concerns, fire, moisture etc); Limited knowledge about building materials	Consumers; End users	Høibø et al. 2015; Lähtinen et al. 2019b; Stern et al. 2018; Toppinen et al. 2018
Urban planning		
(City) building material traditions	Consumers	Høibø et al. 2015 and 2018
Market demand		
Immature market, lack of pull effect; Lack of consumer demand	Consumers	Brege et al. 2014; Hynynen 2016; Hemström et al. 2011

through communication within business ecosystems (e.g., businesses and local governance actors).

Compared to enabling factors in consumption sphere, the number of identified barriers for WMC market development was considerably higher as presented in Table 5. They cover especially issues connected to the themes of Sustainability in building (e.g., especially product features) and Stakeholder awareness (e.g., limited knowledge on materials), but also to the themes of Urban planning (building traditions in cities), and Market development (e.g., lack of consumer demand). Similar to the results on the enabling factors consumption sphere, the only key actors identified in connections with the barriers in consumption sphere were the end users and residents. This also shows that in the existing research on WMC market development, both information on the linkages between consumption and production spheres, and possibilities of actors to affect the WMC marked development as stakeholders in the system is largely missing.

Fig. 4 summarizes the results on the linkages between the existing research information on the eight themes of enabling factors and barriers in relation to SHP. In the illustration, missing circles in consumption sphere (e.g., lack of circle on Market development) depict themes, which have not been addressed from that perspective in the reviewed literature. In themes, characteristics defined as enabling factors are marked with blue, while barriers are colored with red. As can be seen, from the perspective of housing markets, the focus of previous studies has been on the issues related to production sphere, while consumption sphere has gained considerably less attention. In addition, information on the issues connected to exchange sphere is according to our results currently non-existent. However, also information on issues connected to production sphere is also unbalanced and especially knowledge on Market demand is very narrow and linked dominantly with the identification of barriers instead of bringing a more balanced view on WMC market development potential.

Like described in the detailed results on the production and consumption spheres (Table 2, 3, 4, 5), also knowledge on the potential of actors to play key roles for WMC market development

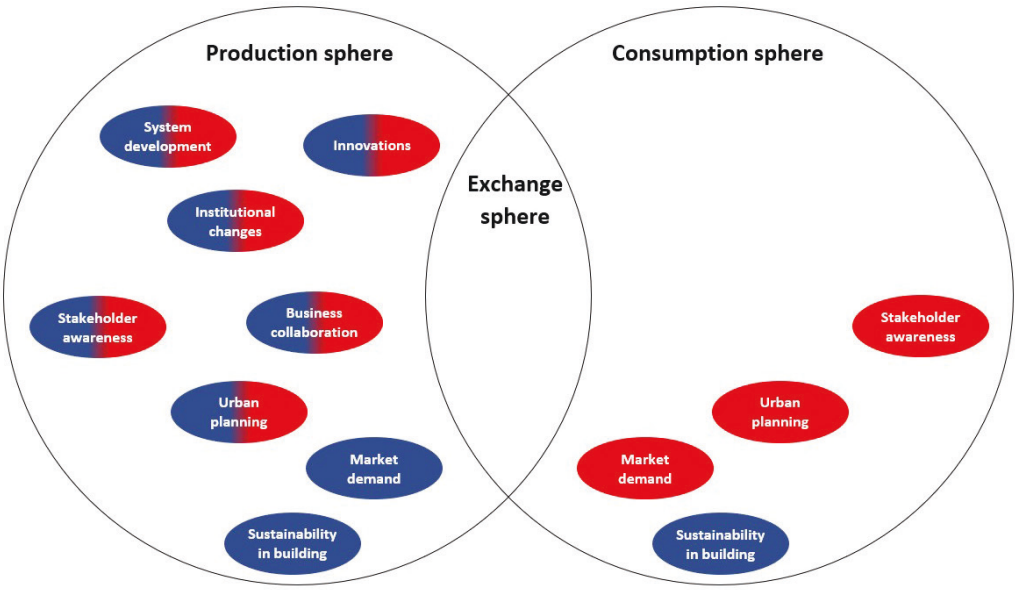

Fig. 4. Existing research information on the themes connected to the structures of housing provision. Enabling factors are denoted in the figure with blue, and barriers with red. Missing circles in exchange and consumption sphere illustrate lack of research information on those issues at the moment.

is limited and siloed. Regarding production sphere, the focus of research has been mainly on those value-chain actors, who are directly involved directly in the construction processes (i.e., product manufacturers, engineers, and construction companies). Contrastingly, the actors who could, for example, through business ecosystems enhance value co-creation (e.g., local-level governance actors or residents) have been largely by-passed in the existing research.

Regarding the third research aim on approaches used, of the 42 articles, 67% (n=28) articles used a qualitative approach, 24% (n=10) a quantitative approach and 9% (n=4) used a mixed approach. Among the articles that used qualitative approach the most used way to describe the study was to call it a case-study or a multiple case-study (n=16). Almost all the articles with a quantitative approach were described as a survey (n=9). In the case of data gathering method, the most commonly used method among the qualitative articles was interviews, which was used in 25 out of 28 articles, although only 14 of these articles relied solely with interview as a method to collect data. Other methods to collect data in the qualitative approaches were the use of focus groups, literature collection, secondary data collection, surveys and workshops. In the quantitative articles, nine out of 10 used a questionnaire/survey to collect the data.

5 Discussion

In this systematic literature review, we analyzed and synthesized the current scientific literature on the factors related to wooden multi-storey construction (WMC) demand, supply and local governance. Our specific aim was to synthesize the key barriers and enabling factors for WMC market development and identify the key actors mentioned in the WMC literature. In addition, we also summarized the types of research methods and analytical approaches used in the previous studies. As a method of analysis, we followed a PRISMA method.

Our results are based on 42 relevant peer-reviewed articles published in 2006–2020, while the volume of activity appeared to have increased in 2018–2020. Technological development towards industrialization in the construction industry and possibilities to use wood-based solutions in the multi-storey building started to gain increasing attention in the early 2000s (Schuler et al. 2001; Jonsson and Rudberg 2014). Our results indicate that research inputs on the WMC market development evolved after the phase of research focus on technological views on industrialization and wood building. Despite the increase in the number of peer-reviewed studies connected to WMC market development especially in the context of housing markets since 2006, international scientific research on theme is still very much in its' infancy.

Our results suggest that some of the key enablers include benefits arising from increased prefabrication, such as increased material efficiency in construction processes, resulting in lower material costs, and rapid installation (Persson et al. 2009; Roos et al. 2010; Markström et al. 2018). In addition, wood is perceived to bring benefits in the WMC, especially among wood manufacturing companies and architects (Nordin et al. 2010; Riggio et al. 2020; Peters et al. 2020), but this push is not sufficient to rapid acceleration of WMC business, at least not yet. As a barrier to system development, the lack of experience from using wood in multi-storey construction, and the path dependencies with concrete and steel construction continue to be the key hindrances for mainstreaming of the WMC (Mahapatra and Gustavsson 2008; Riala and Ilola 2014; Hemstöm et al. 2017). However, the demand side enablers and barriers remain a great unknown, due to a gap in research.

Although housing markets function as a system of production, consumption and exchange, our results show that the information on WMC market development is still under-developed. In reference to structures of housing production (SHP) (Burke and Hulse 2010), actors in exchange

sphere are important as intermediates in the housing markets (e.g., mortgages, insurances) (Österling 2017; Jussila and Lähtinen 2020), but according to our results no research has been made on their roles in the WMC market. In addition, literature on WMC market development has focused mostly on production sphere, while knowledge on consumption sphere is far more limited both regarding the themes and key actors to affect the changes in the construction industry systems. Furthermore, peer-reviewed article results addressing consumption sphere are geographically more limited than information on production sphere concerning mainly information on the Nordic region. Abreast with this, research on local governance mechanisms is also limited, drawing scattered evidence focusing on studies from only Sweden and Finland.

The key actors covered in the literature include businesses, for example, contractors, element manufacturers and architects, and the members of WMC business ecosystem, such as public authorities and residents. In addition, regarding business actors, most of the research information on companies connects directly to wood industries (e.g., manufacturers of modules). With construction industry being associated with a high degree of specialization, at local and project levels, future development would require a highly diverse set of actors and related skills to be incorporated in production sphere (Toppinen et al. 2019a). Small scale actors often have limited resources to uptake new technologies and acquire new skills. Possibilities to start to use new building systems and change business logics may be supported through collaboration activities (Brege et al. 2014), which enhance accumulation of special expertise and knowledge to build with wood also in as a part of project-driven business ecosystems (Viholainen et al. 2021a; Lähtinen et al. 2022).

From a methodological perspective, we can conclude that the literature is currently dominated by case studies and the use of qualitative data sets. This hinders the generalizability of findings in different regional contexts or across groups of different actors. A few surveys existing in the literature have been targeted to consumers and architects focusing mostly on the aspect to affect their demand and preferences for wood materials. To have broad understanding on the factors affecting WMC market development in different regional contexts, both qualitative and quantitative studies addressing views of multiple actors in relation to characteristics of housing markets would be needed.

In future studies, more in-depth information is needed on WMC market development. First, there is a need for more longitudinal research on the forms of collaboration with actors in the construction value-chains and emerging business ecosystems (e.g., actors related to exchange and consumption spheres in the system of housing provision). Research on municipal decision-making, land zoning, financing aspects and intermediaries involved in the housing markets were limited (see e.g., Vihemäki et al. 2020). Second, more information is also needed on how more open innovation culture between different actors could be enhanced to broaden the collaboration networks for value co-creation and accumulation of new skills. Third, there is a need to understand better factors enabling formation such forms of collaboration, which would better enable sharing the risks in WMC projects, since this topic was hardly touched upon in the sample. Fourth, studies could also explore ways to turn environmental performance into housing quality attributes through new construction industry practices. Finally, acknowledging better the versatile needs of end-users, for example in terms of modularity of housing, and flexibility in terms of changing uses over building life span, is still needed.

Implementation of a systematic literature review requires pre-determining the timespan and criteria for the material searches. Although the use of PRISMA framework adds transparency of the results, the method also has some limitations. Our literature searches were targeted in the timespan of 2000–2020. Due to that, it is possible that studies, which had been published earlier were not included in the initial material of this study. However, since the number of hits received at the identification phase of the literature review process was already considerably high (over 7000), it

would have not been feasible to have additional years included in the searches. In addition, since the research group made preliminary evaluations for the WMC literature, it was known that most of the studies addressing WMC market development had been published in the past two decades. Regarding selection of language, the systematic searches were targeted at peer-reviewed articles published in English in Web of Science and Scopus.

The research group would have had limited possibilities to read the articles also in several other languages. However, since English is the dominant language for peer-reviewed publishing, searches were implemented only in one language. This also added the conceptual coherency of the materials. Since the key words used were identified from previous literature connected to WMC market development, the research on building technologies and assessment of environmental impacts therefore were not in the scope of this study. Moreover, since we also explicitly wanted to focus on WMC, the larger body of literature around housing, especially the use of wood in single-family housing was omitted.

Our results show that information exists on how possibilities in production sphere, and more specifically, how issues connected to prefabrication and sustainability in building may contribute to WMC market development. Contrastingly, there is a critical gap of knowledge on the factors, which affect the demand of WMC homes (i.e., consumption sphere) in the housing markets. So far, the focus of research on WMC apartments has mostly been on their supply (i.e., production sphere) in the housing markets, while consumer expectations for WMC homes have gained considerably less of attention. In addition, information on the role of financial issues such as the role of mortgages and insurances (i.e., exchange sphere) affecting both supply and demand of homes is entirely lacking in relation to WMC market development.

As a conclusion of our study, there is momentum for the sustainability-driven forestry-wood construction value-chains to challenge the dominant concrete-based construction regime through WMC market development. However, to make a change in the construction industry, WMC must be viewed also in the context of the housing markets, not only through supply mechanisms mainly connected with technological benefits and cost-efficiency gains.

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Authors' contributions

Jaakko Jussila: Original idea of the article, planning and design of data gathering, formulation of the research questions, selection of the theoretical framework and design of the analysis, implementation of the analysis, interpretation of data and the results, scientific writing of the manuscript, finalization of the manuscript.

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Supplementary files

S1.pdf; Details of literature review process used in the article, available at https://doi.org/10.14214/sf.10609.

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Effects of institutional practices on delays in construction – Views of Finnish homebuilder families

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For many consumers, buying a home is the most important purchasing decision they will ever make. Although consumer needs are well met in the detached house business, particularly compared to the multi-story house business, deficiencies still exist. These deficiencies are caused not only by companies' strategies, but also by institutional factors discouraging the development and launch of innovative business solutions. The purpose of this study is to provide information on the role of institutional practices in the housing markets and construction sector that cause delays in detached house building processes. The analysis employed qualitative data gathered from homebuilder families by phone interviews in January 2015. According to the results, institutional practices pose many challenges in building projects (e.g., acquiring of building permits and financing). In the future, the project planning phase in particular should be developed (e.g., area construction business models and administrative services) to decrease delays caused by purchasers' lack of decision-making power and administrative skills.

Keywords: housing market institutions, detached houses, consumers, building processes, delays

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1. Introduction

This paper analyzes the role of institutional practices in housing causing delays in detached house building processes. Delays are among the most crucial and common obstacles in the building processes, causing potentially high costs for all partners involved (e.g., Zarei et al., 2017). Due to the complexity of the construction projects (e.g., Dubois & Gadde, 2002, Blayse & Manley, 2004), the use of prefabrication has become more common to streamline construction operations for enhancing speed of the processes through more efficient division of work, for example. From the perspective of institutionalization, the standardization of roles and tasks reduces the need for communication and formal documentation, which in turn decreases risks caused by uncertainty (Kadefors, 1995). In this study, we address institutional practices as causes of building delays and suggest solutions for empirical development in detached house building system.

For many consumers, buying a home is the biggest and most important purchasing decision they will ever make (Levy et al., 2008). After making the initial decision, the consumer still has to solve issues related to factors such as the type of property (e.g., a detached house or an apartment in a multi-story building), age of building stock, qualitative characteristics of the dwelling (e.g., floorplan), location and source of financing (Kauko et al., 2002; Koklic & Vida, 2011). The final choice is an outcome of individual factors such as preferences and budget constraints combined with external circumstances like housing market conditions (e.g., supply of houses) arising from different types of institutional practices (e.g., municipality planning and organization of work within and between construction companies) (Levy et al., 2008; Coolen & Hoekstra, 2001; Lindberg et al., 1989; Leishman, 2015).

Regardless of the type of property (i.e., a house or an apartment), the drivers for buying, especially in the case of a new dwelling, are related to expectations for ease of living (e.g., availability of modern housing technologies and no need for renovations) (Hasu, 2018). In

comparison with buyers choosing flats in new multi-story houses, consumers who end up deciding to buy or build a detached house have considerably more power to affect different characteristics (e.g., floorplan, materials) of their homes as a result of differences in business logics and building processes between companies producing houses for the detached and multi-story housing markets (Segerstedt & Olofsson, 2010). Compared with many other countries (e.g., Ball, 1998; Leishman, 2001), detached house construction in Finland are often managed by the homeowners instead of speculative construction by companies (Ruonavaara, 1996a).

Along with decision-making power in the purchase phase, the motivation for choosing a detached house has been found to be connected to the broader social context, such as the prevailing ideal of what constitutes good housing (Marsh & Gibb, 2011). For example, according to a Pan-European study (Norris & Domański, 2009), the quality of Finnish housing is good regardless of the type of home in question. Despite this, living in an owner-occupied detached house has been and still is preferred in Finland, which historically has been caused by Finnish policies and work of non-governmental organizations strongly promoting detached housing as an ideal form of living, especially during the 20th century (Ruonavaara, 1996b). In addition, in Finland owning a house is not only related to social values and norms connected to, e.g., intergenerational family relations, but also wealth reserve acting "as their last resort safety net" (Naumanen & Ruonavaara, 2016). Similarly also in Denmark, for example, the characteristics of detached houses (i.e., style, size and location) have been found to serve as symbols of family-building and position in society for their owners (Gram-Hanssen & Bech-Danielsen, 2004).

According to Gibler & Tyvimaa (2014), socioeconomic changes (e.g., increase in income and wealth) have led to diversification in the housing expectations of customers, which has started to pose pressures to provide more options for personalization in house design. However, they also pointed out that from the perspective of housing companies, factors such

as local regulations, control of buildable land and control of building design discourage the development and launch of innovative business solutions that could further enhance the profitability and customer-orientation of companies. In line with this, it has been found that not only decisions made within building companies, but also politically devised instruments and regulatory factors affect the diffusion of innovations in the construction sector (e.g., Blayse and Manley, 2004). Furthermore, solutions made in urban planning processes at the level of municipalities have had major effects, such as on the possibilities of building companies to strategically renew their businesses (e.g., Lähtinen et al., 2019). Thus, several institutional processes and norms (e.g., social, demographic, economic and legal) (Burke, 2012) governed by actors connected to production (e.g., constructors), consumption (e.g., purchasers) and exchange (e.g., lenders) affect the housing system illustrated with Structures of Housing Provision (SHP) (e.g., Ball & Harloe, 1992).

The construction sector has been broadly criticized for its lack of innovativeness (Vesa, 2014). For example, housing construction in the UK has been accused of being locked in by inefficient traditions of building, even though these shortcomings have been recognized and government policies have been instituted to encourage renewal in the sector (Lovell & Smith, 2010). Similar findings have been made in Denmark, where low productivity and poor quality have been identified as general problems for the whole construction sector (e.g., Kristiansen et al., 2005), and the state has played an active role in promoting innovativeness through interventions and direct legislative actions (Bang et al., 2001; Rasmussen et al., 2017).

Despite the development potential and needs of the detached housing business, relatively little research information exists on the role of institutions and practices of institutional actors affecting the performance of businesses especially from the perspective of homebuilders. In addition, since consumers make home purchasing decisions on the basis of imperfect information (Marsh & Gibb, 2011), special attention is paid to factors causing delays

in building processes by also taking into account the possible linkages of prefabrication to the extent of the challenges experienced by house purchasers. Related to this, the overall purpose of this study is to fill the existing gap in the research information on the role of institutional practices and means affecting the building processes of detached houses especially from the perspective of delays. Abreast with institutional theories (e.g., Selznik, 1996), the SHP framework (e.g., Ball & Harloe, 1992) is applied to structure the role of private home purchaser in the Finnish detached housing system. By tapping into a better understanding of the viewpoints of their customers, companies could seek possibilities to enhance their customer orientation during building projects and occupancy. Due to the strong traditions and consumer preferences for detached house ownership in Finland, the country provides an appropriate case territory for studying this phenomenon.

2. Detached housing markets globally and in Finland

In advanced economies, the housing market is a major branch of the economy from the perspectives of gross domestic production (GDP), construction sector employment and expenditures of households (MacLennan et al., 1998). Moreover, the sector significantly affects employment and economics in other sectors, such as the manufacturing industry, logistics and services (Giang & Sui Pheng, 2011). Regarding the proportion of different types of dwellings in the housing markets, approximately one quarter of people in the European Union (EU) live in owner-occupied homes and one third in detached houses (Eurostat, 2018). Thus, when comparing the characteristics of housing markets in Finland with some other European countries (Table 1), the proportion of detached houses in Finland is comparable to Sweden and the average in the EU, while in Germany the proportion of detached houses is considerably higher (i.e., approx. 50% of the dwellings).

Table 1. Examples of housing markets in different countries (mod. from Steinhardt et al., 2013).

Country	Prefabrication	Types of new houses
Finland Annual dwelling completions 36,000 (Statistics Finland, 2017)	Prefabrication of components and whole houses Offsite construction 70–75% of new detached houses (Omakotirakentaja 2016)	20% detached houses 70% multi-residential houses 10% other (Statistics Finland, 2017)
Sweden Annual dwelling completions 42,000 (Statistics Sweden, 2018)	Approx. 50-90% of house building is offsite (Fröjdfeldt & Leijon, 2008) Proportionally most commonly used in the manufacture of private, detached homes (Andersson, 2005, as cited in Steinhardt et al., 2013)	27% detached houses 73% multi-residential houses (Statistics Sweden, 2018)
Germany Annual dwelling completions 316,000 (Federal Statistics Office Germany, 2018)	13% of new residential building permits were for prefabricated buildings in 2016 17% prefabrication of detached or semi-detached houses, 4% multi-residential houses (Federal Statistics Office Germany, 2018)	38% detached or semi-detached houses 55% multi-residential houses 7% other (Federal Statistics Office Germany, 2018)

In Finland, the construction sector has represented roughly 6% of national GDP during the past five years (Statistics Finland, 2018a). In 2016, the construction sector generated turnover of 33 billion euros and employed 157 700 people (Statistics Finland, 2018b). Although preferences for housing in Finland have diversified (e.g., Gibler & Tyvimaa, 2014), most Finns still prefer detached house as their type of dwelling (e.g., Suomi Asuu, 2015).

The construction market in Finland has become rapidly concentrated in the Helsinki area and other biggest cities commonly seen as the future growth areas, whereas smaller towns and the countryside are seen to have very little growth potential. The Helsinki capital area covers almost half of all new residential apartments but only about 30% of new detached homes. Furthermore the six biggest cities and their neighboring communities cover about 90% of all new dwellings and about 70% of new detached homes. (Omakotirakentaja, 2016.)

Detached homes can thus be seen to being concentrated more towards urban areas although they are a logical choice for new house type in the rural area.

The trend towards urbanization in Finland is a major phenomenon affecting the demand for detached houses and construction business companies have recognized that there is a need for innovation activities to find urban solutions for housing (see, e.g., Tykkä et al., 2010). Opportunities for developing detached house building businesses exist, since detached house dwellers' preferences on the location and other characteristics of their homes are heterogeneous and affected by different types of lifestyle issues, for example (Gibler and Tyvimaa, 2014).

According to Omakotirakentaja (2016), building starts of new detached houses in Finland decreased by 47% in the 2000–2015 period (Figure 1) as urban planning has focused largely on multi-story buildings due to the population shift into the biggest cities. In the Finnish housing markets, roughly 7000 new detached houses were built in 2016. As a result of declining markets, the competition among house building companies has been intense during the whole of the 2000s, which has also increased the importance of pricing and product differentiation as factors of competitiveness. From companies' perspective, the sales processes are often long and expensive due to the high involvement of purchasers in planning processes and the common procedure among purchasers is to ask for several tenders from competing firms (Omakotirakentaja, 2016). The proportion of all building starts of new detached houses accounted for by new prefabricated houses increased steadily in the 2000–2015 period from 50% to 80% (Figure 1). Thus, from the perspective of innovations, detached house building companies in Finland can be considered as forerunners in prefabrication, which since the 1960s has been emphasized as an option to enhance the efficiency of production processes and customer orientation among the companies in the building business (Carter, 1967). Among the companies producing prefabricated houses in Finland (approx. 100 in total), the types of

prefabrication may vary by housing company and/or purchaser, ranging from the supply of bearing structures, for instance, to the finishing of the entire house, including its interiors.

A typical new detached home in Finland is built and occupied by the future homeowner. The average floorspace is 167m^2 (living space 142m^2) and two quarters of the houses are single storey buildings. In 2015, 68% of new detached homes were built in cities (6% in the center, 46% to conurbation and 16% in sparsely populated areas) and 32% in rural municipalities. The houses are usually simple: 50% of them have four corners and about 90% have less than eight corners. Despite this, most of the houses are customized (e.g., floor plan, material choices and interior fittings). Open kitchen – living room combination is common and most of the houses have built-in saunas and a fireplace. (Omakotirakentaja 2016.)

Regarding structural materials, over 80% of detached houses in Finland are made with wooden frames (Finnish Forest Industries Federation, 2010). Independently from type of buildings (e.g., detached or multi-storey houses), compared to other construction materials (i.e., concrete, steel and brick) (Schittich, 2005), the strength of wood as a building material is its lightness, which makes wooden components easy to manufacture and transport (Brege et al., 2014; Riala & Ilola, 2014).

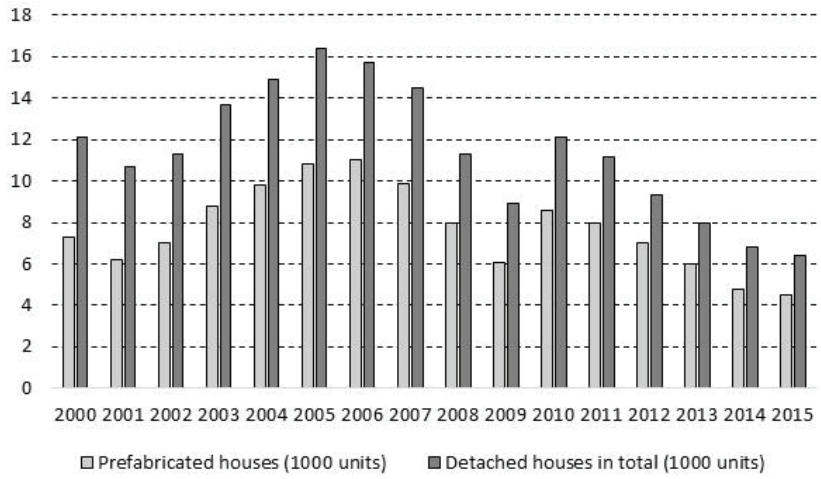

Figure 1. Building starts of detached and prefabricated houses in Finland in the 2000-2015 period (Omakotirakentaja, 2016).

The use of pre-manufactured timber-frame systems and extensive use of pre-assembled modules of internal house fittings are common for the housebuilding industries in timber-rich areas like Scandinavia and North-America (Ball, 2003). In addition, wood is commonly utilized also in other areas as a structural material for detached houses due to cultural traditions and other factors (Schittich, 2005). Due to this, there is strong potential for technological development and diffusion of prefabricated houses in the international markets.

However, the needs for business renewal are related not only to technologies such as uptake of prefabrication to increase efficiency and reduce costs, but also to increasing capabilities to create customer value and achieve price premiums (Barlow & Ozaki, 2003). In all, it would be vital for prefabricated detached housing companies to improve their understanding of issues such as consumers' personal situations and external circumstances in order to enhance the efficiency of the purchasing process and the possibilities of consumers to manage the risks when making the final purchasing choice (Koklic & Vida, 2011).

From the perspective of building processes, the multi-story and detached house building businesses are quite alike at the general level. However, when comparing the roles of home purchasers in multi-storey house and detached house businesses, the first hand owner of has multiple responsibilities in production (e.g., acquiring the lot, participating in the actual construction, choosing the contractors for the project, organizing tendering), consumption (e.g., choosing the solutions and materials according to personal preferences and needs) and exchange (e.g., acquiring the mortgage, making all the contracts and payments related to the project). Figure 2 illustrates the involvement of detached house purchaser in the phases of a Finnish detached house building project, which are connected to the theoretical framework of this study in the next chapter.

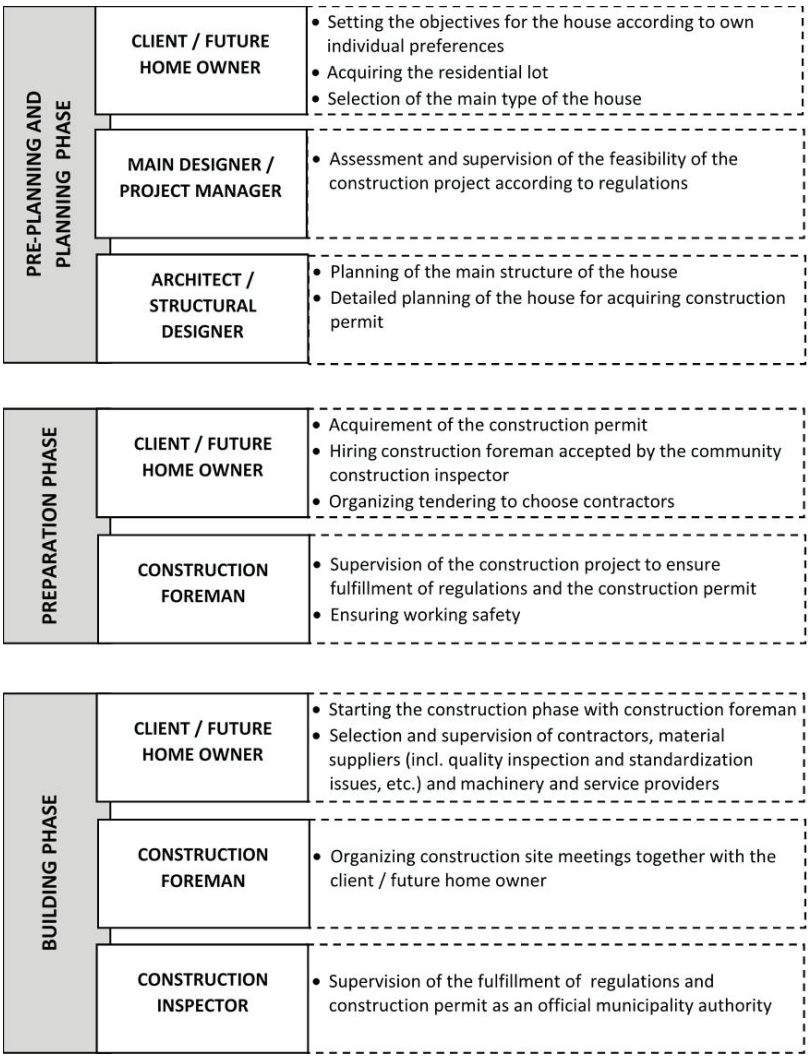

Figure 2. The main building process phases of a detached house in Finland (Puuinfo, 2009; Pientalorakentamisen kehittämiskeskus, 2016).

3. Theoretical background on institutions related to the Structures of Housing Provision (SHP)

Institutions can be defined as the humanly devised rules of the game in a society as well as the social structures that create, embody and enforce those rules (North, 1991; Ahuja & Yayavaram, 2011). Institutional theories focus on tracking the existence of "distinctive forms,

processes, strategies, outlooks, and competences, as they emerge from patterns of organizational interaction and adaptation" (Selznik, 1996). Related to this, one aim of institutional theories is to explain issues such as where the institutional elements arise, to what extent organizational structures are a result of institutionalization, and to what extent institutionalization improves organizational performance (e.g., Zucker, 1987).

According to institutional theories, organizations are influenced by normative pressures leading them to adopt similar patterns of behavior (Zucker, 1987), which increase coordination and reduce the need for information processing, thereby creating efficiency benefits. As information is necessary for any economic activity and none of the actors has more than limited range of expertise, institutions play vital role to reduce risk and uncertainty related to construction (Ball, 1998). In addition, since power is distributed unequally among individual actors in the social systems, collaboration is a form of being part of a network of relationships and communication flows (Booher & Innes, 2002). Yet, institutions also constrain behavior and hinder changes that might have positive impacts on industries in the form of innovation diffusion, for example (Kadefors, 1995; Eriksson, 2013).

The evolution of institutionalism can be traced back decades and in the course of its development, concepts of "old" and "new" institutionalism have emerged (Scott, 2008). In contrast to "old" institutionalism, which approaches development paths leading to institutional divergence, the "new" institutionalism addresses the issues of institutional homogenization (DiMaggio & Powell, 1983; Meyer & Rowan, 1977). According to DiMaggio & Powell (1983), the processes of homogenization can be approached by employing the concept of industrial isomorphism, which is composed of power (coercive isomorphism), attraction (normative pressures), and mimesis (mimetic processes). In addition, Beckert (2010) has added competition as a fourth mechanism of industrial isomorphism.

Institutions have a central role in both human interaction and how firms can do business by influencing, for example, their allocation of resources to productive, unproductive or even destructive activities (Baumol, 1990). Institutions are composed of regulative, normative and cultural-cognitive elements that add stability and meaning to social life. For example in the housing markets, the institutional environment is composed of political, environmental, social and demographic, economic, legal and administrative processes and norms, which separately and together affect the performance of the overall housing system (Burke, 2012). They are highly resilient to change, but can evolve over time and vary in different place or context (Scott, 2003). In addition, along with business organizations, political-legal institutions also cause isomorphic pressures such as by imitating "efficient" tax laws, labor laws, or environmental standards representing "regulatory competition" between states, which has become a central feature of political economies (Beckert, 2010).

Structures of Housing Provision (SHP) refer to the network of relationships associated with the provision of housing at specific point in time (as defined by Ball, 1998 in reference to SHP). In any country, SHP comprise spheres of production, consumption and exchange, which have evolved in the course of time forming country-specific features (Ball & Harloe, 1992). Based on the work of Ball (2003) and Burke and Hulse (2010) production sphere comprises, for example, mechanisms enabling supply of land through institutions affecting land use planning and land ownership abreast with business strategies and division of work within construction companies. In comparison, consumption is composed of, for example, purchasing and ownership preferences of housing and processes of households to purchase homes, while exchange is related, for example, to financial institutions governing monetary instruments enabling sale, renting and use of housing (Ball, 2003; Burke & Hulse, 2010).

According to Boelhouwer and van der Heijden (1993), SHP is not a theory on housing, but rather an approach for describing different housing structures to be further evaluated with

appropriate theories. For example, by combining the institutional theories with the SHP approach, comprehension on the institutional processes affecting the housing system functions may be deepened. From the perspective of SHP, institutions within the spheres of production, consumption and exchange are interlinked to each other through management systems (e.g., institutional practices and means of different actors) (Burke & Hulse, 2010). These interactions affect the governance of the whole SHP system (e.g., finance institutions, home purchasers, building developers, builders and public authorities) (Burke, 2012).

Thus, by connecting institutional theories with the SHP complex nature of housing system can be concretized. For example, impacts of particular institutions do not necessarily reflect only production, consumption or exchange spheres of the SHP, but simultaneously and to a varying extent all of them. As a result of this, when seeking for solutions for particular problems in the housing system (e.g., shortening delays in detached house building processes), understanding these interactions supports perceiving, which of the problems might be solved rather straightforwardly and which might require more profound scrutiny of the whole housing system. For example, in case of construction sector institutions (Kadefors, 1995) tendering system seem to affect production sphere, while governmental regulations have potential impacts on all spheres of SHP through housing policies and financial markets (see Table 2).

In addition, some institutions in the housing system are formal (e.g., norms and regulations on land use planning and building governed through legislation), while some are informal ones (e.g., established forms of operations to manage building processes within business networks) (e.g. Scott, 2003; Toppinen et al., 2019). The level of formality affects the management systems available for actors to govern the SHP (e.g., civil servants implementing land use policies *versus* private home builder bidding tenders), although there are still degrees of freedom for actors in choosing their institutional practices and means (Alexander, 2005). Thus, simultaneously with supporting the institutionalized myths (e.g., organizational image),

formal organizations are required to seek for flexibility to enhance efficiency of their managerial practices (Meyer & Rowan, 1977). As a result of this, there may be considerable variation in the institutional practices even within organizations with high level of formality.

Thus, enhancing comprehension on the causes of delays in the detached housing building processes requires consideration of not only institutions as such, but also their linkages to institutional practices and means of different actor governing the SHP spheres. This is especially relevant in the context of Finland, where the degree of formality of the institutions and the power of different actors to govern the management systems vary considerably. To summarize and depict the multi-dimensionality of the housing system in reference to the SHP and institutional theories, the conceptual linkages of institutions, actors, and management systems (i.e. institutional practices and means) are illustrated in Figure 3.

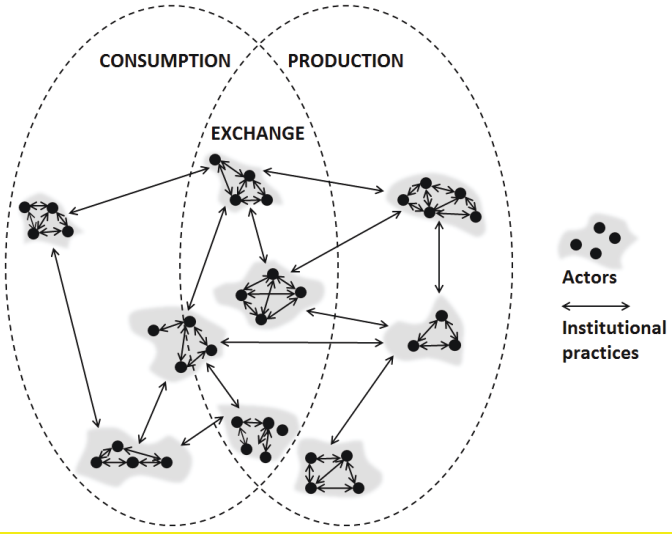

Figure 3. Institutional practices of actors within spheres of production, exchange and consumption in relation to SHP structures.

In the international business environment, economic processes and norms affect both production and consumption of dwellings (Burke, 2012), although the financial mechanisms

vary from one country to another due to differences in their national institutional settings (Österling, 2017). Generally, from home purchasers' point of view, economic institutions affect housing markets through mortgage loan issuance (Kutlukaya & Erol, 2016), which together with interest rates comprises the main driver for demand in the housing market (Warnock & Warnock, 2008). In comparison, housing production is more affected by institutions making decisions on the regulatory environment (e.g., land use policies and building norms) and structures of the construction sector, while the impacts of economic institutions are less straightforward (Warnock & Warnock, 2008). Housing suppliers may indirectly benefit from macroeconomic mechanisms by gaining market advantage through preferential market access or capital market inefficiencies, speculative land purchases and taxation factors (Ball et al., 2000).

Mortgage markets in Europe including Finland – are affected by legal and regulatory issues controlling the loan origination, consumer protection and enforcement of lenders' rights as well as urbanization (Kutlukaya & Erol, 2016). In the EU-level, the European Central Bank (ECB) controls financial markets by setting the basic frames to interest rates, which in turn sets the frame for Euribor rates. The 12-month Euribor is most widely used reference rate for housing loans in Finland. The Bank of Finland has reported that over 90% of all housing loans in the country were tied to Euribor rates in 2014 (Bank of Finland, 2014). Due to this the development of Euribor rates are important for the Finnish housing and construction sector. Another financial institution is the Third Basel Accord by the Bank for International Settlements, which sets framework on bank capital adequacy, stress testing, and market liquidity risk. After the housing bubble in the US in 2007–2009, the banks are more concerned on the collateral value of properties, which thereby has tightened the mortgage lending in Finland in the past couple of years especially in the rural areas.

Abreast with "traditional" economic processes and norms related to, for example, mortgage markets, nowadays the importance of global megatrends (e.g., climate change, urbanization and demographic changes) (e.g., Lützkendorf et al., 2011) have started to play increasingly critical role in the SHP through several institutional processes and norms emerging in international policies (e.g., European Commission, 2014; Ecodesign Directive, 2009). Although regulation has positive impacts on improving housing standards, enhancing sustainable development and creating business opportunities for forerunner building companies (e.g., Andersson et al., 2007; Lützkendorf et al., 2011), it may also cause additional costs, uncertainty and delays in the building processes (e.g., Al-Khalil & Al-Ghafly, 1999). Delays are among the most crucial obstacles to the success and performance of construction projects (Zarei et al., 2017).

Especially from the perspective of home purchasers, inefficient regulation has been found to decrease the diversity of supply of dwellings in the housing market (Puustinen & Kangasoja, 2009) and delimit the possibilities of house buyers to make choices of their own in their home design (Gibler & Tyvimaa, 2014). From the house builders' point of view, impractical regulation increases construction costs and decreases the possibilities for innovation diffusion (Puustinen & Kangasoja, 2009), which have been found to be crucial for mind-set renewal in the construction sector (e.g., Holt, 2013). All in all, compared to less-regulated housing markets, in the areas of extensive land use regulation the amount of new building starts has been found to be 45% lower (Mayer & Somerville, 2000).

The next goal to be achieved by 2020 is the introduction of so-called net zero energy balance (NZEB) buildings that will produce all the energy they require on-site. In case of detached houses located in northern European countries such as Finland, achieving NZEB requires the development of innovative energy systems for buildings (Mohamed et al., 2014). In the construction sector, these required advancements in technologies may create new

business opportunities for forerunner companies if their impacts on purchasers can be communicated, such as their possibilities to enhance the quality of living (Lützkendorf et al., 2011; Toppinen et al., 2018).

Institutions and individual actors with their practices affect the potential for renewal for the construction industries (Rasmussen et al., 2017). Abreast with industrial building, for example needs related to sustainable construction and enhancement on customer orientation are driving the needs for changing the detached housing business. For empirical categorization of the construction sector institutions, a framework introduced by Kadefors (1995) is being employed. The framework consists of six elements of institutions: "Governmental regulations," "Tendering system," "Formal standardization initiated by the industry," "Standardization of skills and knowledge," "Roles and interest organizations" and "Learning and routine". In Table 2, the categorization of institutions is supplemented with examples on the roles of different actors as well as their means and practices (Scott, 1987) in the detached house building processes. At the phase of qualitative analysis, information in Table 2 is employed to identify and evaluate the potential causes of delays faced by Finnish detached house builders by taking into account also the connections of institutional practices to SHP system.

Table 2. Institutions in the construction sector combined with examples of their linkages to means and practices of institutional actors (modified from Kadefors 1995).

Institution	Actor(s)	Practices and means
1. Governmental regulations	EU-level, national, regional and local officials and politicians	EU-directives, national and local regulation and policies affecting eg,housing policy, urban planning and financial markets. Ensuring that good practices are being followed in building permit procedures, building supervision, technical solutions and usage of buildings (e.g., Land Use and Building Act (132/1999))
2. Tendering system	Future homeowners, main contractors and sub-contractors	Competitive bidding systems, established/familiar contractor contacts. Using bidding processes to find an optimal combination of suppliers for a given construction project, for instance (e.g. Hatush & Skitmore, 1997).
3. Formal standardization initiated by the industry	Industrial and standards associations, manufacturers and suppliers, EU authorities and officials	Guidelines, accreditations, formal sertifications and terms of delivery. Assuring that components and technologies are applicable with each other independently from selected suppliers in the bidding processes (Dubois & Gadde, 2002)
4. Roles and interest organizations	Industrial associations and non-governmental organizations	Lobbying and guidelines for practitioners, voluntary sertifications and reporting systems. Facilitation of knowledge diffusion throughout the construction sector and provision of normative directions for member companies and other organizations, such as through negotiations and lobbying (Vermeulen et al., 2007)
5. Standardization of skills and knowledge	Home manufacturers, main designer, contractors, consultants, project manager, project supervisor, construction foremen, clients and future homeowners.	Information exchange and experience, formal and informal education. Trial and error, development of new practices. Enhancing capabilities to re-engineer construction processes and define new “best practices” without compromising efficient and error-free project implementation (Roy et al., 2005).
6. Learning and routines	All the above	Social skills and informal collaboration among actors. Communication capabilities. Developing social patterns, practices and processes that support the dissemination of information and knowledge diffusion between separate projects, and also enhancing the uptake of new routines and process innovation capabilities as, for example, customer needs become more diverse (Bresnen, 2003).

4. Material and methods

The material of this study (Table 3) is composed of survey data gathered in January 2015 as a part of Rakennustutkimus RTS Oy's "Omakotirakentaja" series of surveys carried out annually since 1983. The data gathering process was targeted by phone interviews at 2,404 families, who in the fall 2014 had acquired building permit in Finland to start a detached house construction project.

Table 3. The material of the study.

Initial sample	Data gathering process	Final data
2,404 people were contacted twice by phone*	772 people could not be reached after two attempts	Responses of 661 people on three questions for further analysis: Question 1: "Have you had major delays from the original schedule in your building project? If so, what kinds of problems were these and what are your views on the reasons for the problems?" Question 2: "Have you faced problems in acquiring the plot? If so, what kinds of problems were these and what are your views on the reasons for the problems?" Question 3: "Have you faced problems related to acquiring the building permit? If so, what kinds of problems were these and what are your views on the reasons for the problems?"
	485 refused to participate in the study	
	181 interrupted the interview during the phone conversation	
	305 were disqualified for various reasons (e.g., the person provided an incorrect phone number or construction was not relevant to them	

**The contact information of the sample was ordered from the Population Register Centre (http://vrk.fi/en/frontpage), which in Finland in the official authority to manage population information system.*

In all, the survey consisted of 24 questions, of which questions on the level of prefabrication progress of the building project were addressed in the analysis of this study. The data analysis was implemented both quantitatively and qualitatively in three stages as described in Table 4.

The quantitative analysis was based on calculus of frequencies and the statistical nonparametric Mann-Whitney U test (also known as Wilcoxon rank sum test), executed with

IBM SPSS Statistics software to check whether statistical indications on connections between the existence of major building delays and the level of prefabrication could be found. The motivation for using nonparametric test procedure was twofold: First, Mann-Whitney U Test does not assume that the data in each group tested would be taken from normally distributed populations. Second, it is appropriate to be utilized in cases where calculus of mean is not statistically justified (e.g., ordinal data on occurrence of building delays and level of prefabrication) (Berenson et al., 2002).

In qualitative analysis, data thematization was employed to add comprehension on the magnitude of institutional practices as factors having negative effects on detached house building projects. As a method, thematization suits for evaluating a specific phenomenon in concrete contexts, especially as it asks respondents to describe their internally meaningful experiences without predetermined structures (Holloway and Todres, 2003). In this study, thematization was employed both as data-driven and theory-driven approaches to check what kinds of categories of delays could be identified independently from theoretical assumptions, and what could be recognized in reference to theoretical background on institutions and SHP.

Table 4. The three stages of data analysis implemented with quantitative and qualitative approaches.

	Purpose of analysis	**Data coding**	**Methods of analysis**
First stage (Information on the level of prefabrication and Question 1)	Information on occurrence of building delays	0=No, no major building delays 1=Yes, major building delays	Frequencies of respondents with and without experiences on building delays by level of prefabrication of their houses (Quantitative approach) Mann-Whitney U test to assess statistically the connections between experiences on building delays and level of prefabrication of the houses (Quantitative approach)
	Information on the level of prefabrication in purchased houses purchased	0=No information on the level of prefabrication 1=No prefabrication, 2=Some level of prefabrication (i.e., building structures, but not interiors) 3=High level of prefabrication (i.e., building structures and also all or most of the interiors)	
Second stage (Questions 2 and 3)	General information on the occurrence of delays especially at planning and preparation phases of the building project	Data-driven thematization	Frequencies of experiences on different types of general delays (Quantitative and qualitative approach)
Third stage (Question 1)	Detailed information on causes of building delays during different building project phases	Theory-driven thematization in reference to Kadefors (1995) and SHP	Frequencies of experiences on delays caused by different institutional practices (Quantitative and qualitative approach)

5. Results concerning institutions affecting the performance of detached home building processes

5.1 Prefabrication and general causes for delays

According to the results of the first stage of analysis, altogether 168 interviewees, representing 26% of the 661 respondents, had experienced major delays in their building projects (question 1). From the perspective of the role of prefabrication, the results in Table 3 suggest that the occurrence of major building delays had not differed by level of prefabrication (i.e., percentages of the level of prefabrication were quite alike between the respondents without and

with experiences of delays). This finding is also supported by the results of the Mann-Whitney U test for independent samples, according to which no indications of statistically significant differences between the groups were detected (p-value=0.754). Based on this, the level of prefabrication was regarded to be irrelevant from the perspective of analysis of the role of institutions as factors causing building delays. In addition, compared to the proportion of prefabricated house building starts in the Finnish detached house markets in 2014 (71%), the share of prefabrication (i.e., some level or high level of prefabrication) in the material of the study (69.7%) is almost the same (see Figure 1 and Table 5).

Table 5. Frequencies and proportions of groups of respondents by experiences of major building delays and the level of prefabrication of the purchased detached house.

	No information on the level of prefabrication	No prefabrication	Some level of prefabrication	High level of prefabrication	Total
No, no major building delays	13 (2.6%)	132 (26.8%)	220 (44.6%)	128 (26.0%)	**493 (100 %)**
Yes, major building delays	9 (5.4%)	46 (27.4%)	68 (40.5%)	45 (26.8%)	**168 (100%)**

The second stage of analysis was more specifically related to the more detailed question 2 (i.e., issues with the plot) and question 3 (i.e., issues with the building permit), providing information at a general level on the issues that had caused major delays especially in launching the detached house building projects. In all, 122 interviewees (18%) had faced problems with the plot (question 2) and 109 (16%) with building permits (question 3). Geographically, the respondents that had experienced delays represented the whole of continental Finland. Thus, no geographic differences were identified in the occurrence of building process delays between

different areas of Finland. The general reasons for delays mentioned by the respondents and the proportions of the 168 respondents with experiences of those delays are illustrated in Figure 4.

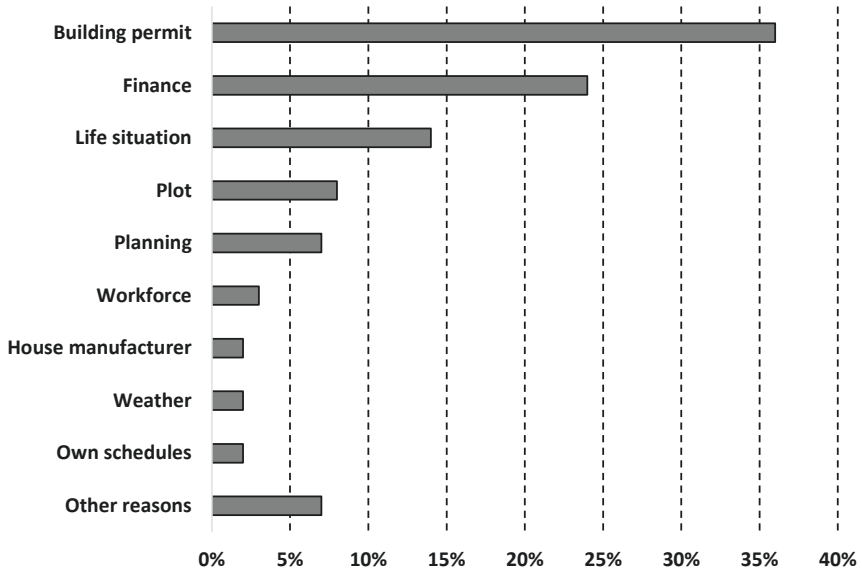

Figure 4. Experiences of different types of delays in detached house building projects faced by the respondents (n=168).

Based on the experiences of the respondents, the most important single cause of delays in house building projects (over 35% of the respondents) stemmed from issues related to building permits, while problems with finance also had quite notable impacts (close to 25% of the respondents) on the performance of the processes. From the perspective of the institutional practices, building permits are related both to the legal and administrative processes and norms (i.e., governmental regulations) within the SHP (Figure 3) production sphere. In addition, the result concerning financing as a factor commonly affecting performance in building projects is in line with the previous literature (Warnock & Warnock, 2008), emphasizing the major role

of mortgage loan issuing and interest rates as drivers for exchange and consumption for housing in the SHP system. However challenges with finance can be related both to governmental regulation related to financial markets and purchasers' individual financial management and/or budgeting skills affecting their possibilities to receive mortgage. Thus interpreting what the respondents mean as "finance problems" in the data is ambiguous.

Apart from institutional practices, the general life situation of the respondents had a considerable effect (close to 15% of the respondents) on construction processes. However, as unexpected changes in life (e.g., the birth of a child, divorce or lack of time) are often beyond one's control, results related to them can be considered to be part of the general risks involved in home building projects (e.g., Mulder & Lauster, 2010) related to the consumption sphere of SHP. All in all, the processes under the responsibility of suppliers of the dwellings (i.e., planning, workforce and house manufacturer) played a relatively minor role overall in the different types of delays faced by the respondents.

5.2. Institutional practices as specific causes for delays

The final and third stage of analysis comprised data categorization of detailed descriptions and views of the reasons behind the problems experienced by respondents, especially with respect to institutional practices within the construction sector (Kadefors, 1995) by also considering their linkages to the SHP (e.g., Ball & Harloe, 1992). In all, a total of 115 respondents (i.e., 68% of the respondents with experiences of some types of delays) mentioned in their answers issues, which in the analysis were associated with practices of construction sector institutions.

Delays caused by institutional practices had impacts on either one or several building project phases (Figure 2). Although most of the respondents specified only one type of delay they had experienced during their building project, there were 14 interviewees who had faced several types of delays in their projects. Due to that, the sum of frequencies for delays

mentioned by the respondents (Table 6) is higher than the total number of respondents with experiences of institutional types of delays (n=115).

Table 6. Frequencies for different types of delays in reference to individual institutions at different building process phase(s).

Institution	Preplanning and planning phase	Preparation phase	Building phase	Total
Governmental regulations	8	43	4	55
Tendering system	-	1	7	8
Formal standardization initiated by the industry	5	3	-	8
Roles and interest organizations	-	-	-	0
Standardization of skills and knowledge	48	8	11	67
Learning and routine	2	1	1	4

As illustrated in Table 6, institutional practices connected to "Standardization of skills and knowledge" (e.g., deficiencies in capabilities to organize and to keep on schedule and understand the risks of financing the project) was the most important cause for delays, especially during the planning phase. In reference to SHP, the result indicates deficiencies in the production sphere of the detached housing system. The result is logical, as the detached house building projects are managed by homebuilder families as a difference, for example, to industrial multi-storey construction processes managed where professional building developers are responsible for organization of work. Abreast with the practices mainly under responsibility of the homebuilders themselves (e.g., organization of work in planning phase), institutional practices linked to "Governmental regulations" governed by public officials within the production spheres of the SHP very frequently caused delays in building projects, especially during the preparation phase (e.g., the slow bureaucracy involved in obtaining a building permit).

In addition, the respondents mentioned practices related to "Tendering system" (e.g., problems with the contractors, subcontractors or house building company), "Formal standardization initiated by the industry" (e.g., challenges with the designers making the plans for the house) and "Learning and routine" (e.g., lack of "chemistry" between the actors). In reference to SHP, these issues are also connected organization of work within production sphere illustrating well the two-fold role of homebuilders in the detached house construction sector business. Compared to industrial building, in detached house building the future home owners are not only within the consumption sphere of the SHP system, but through involvement in management of building processes also strongly involved in the production sphere.

However, the practices related to "Tendering system", "Formal standardization initiated by the industry" and "Learning and routine" were notably less common causes for delays than the ones related to "Governmental regulations" or "Standardization of skills and knowledge." In some cases, problems with certain institutional practices reflected in several building project phases. For example, one respondent had faced challenges in building a type of detached house that is relatively new in Finland, as many actors lacked the necessary know-how, which cumulatively affected the overall performance of the building project (i.e., many kinds of deficiencies had emerged in "Learning and routine").

All in all, the interrelationships between the institutional causes of delays and project phases were quite clearly related to an individual building project phase and practices connected to one type of institution and its practices. Examples of the typical problems by building project phases mentioned by the respondents are illustrated in the quotes below:

Preplanning and planning phase

"Standardization of skills and knowledge": Respondent #5 *"Selling the old apartment did not proceed as was hoped"* or Respondent #82 "*Problems with the bank in securing a mortgage loan*."

"Governmental regulations": Respondent #3 "*Preparation of the city plan took years*" or Respondent #32 "*Changes in the city plan.*"

Preparation phase

"Governmental regulations": Respondent #95 "*Acquiring the building permit took six weeks more than promised*" or Respondent #35 "*Summer holidays of the city [planning] employees."*

"Standardization of skills and knowledge": Respondent #75 "*Paperwork was demanding"* or Respondent #167 "*Official paperwork."*

Building phase

"Standardization of skills and knowledge": Respondent #6 "*Maybe a little, when doing-it-yourself, the schedule has been stretched*" or Respondent #144 "*More excavation work was required on the building site than expected."*

"Tendering system": Respondent #34 "*[Problems in] acquiring the excavator postponed the preparation of the foundation*" or Respondent #139 "*Receiving tenders was scarce.*"

To supplement the results concerning the impacts of practices within individual institutions on delays, the existence of adverse effects on building performance caused simultaneously by modes of operations within two institutions were also examined. In all, 16 respondents (14% of the total amount of respondents who had experienced some delays) had encountered challenges in the building projects that from the perspective of analysis had characteristics of practices executed in two institutions. Regarding the contribution to the results, the explanations for the causes of delays in these cases were probably less ambiguous and as such were expected to provide some insights into the dynamics between the institutions and the risks they caused for home purchasers.

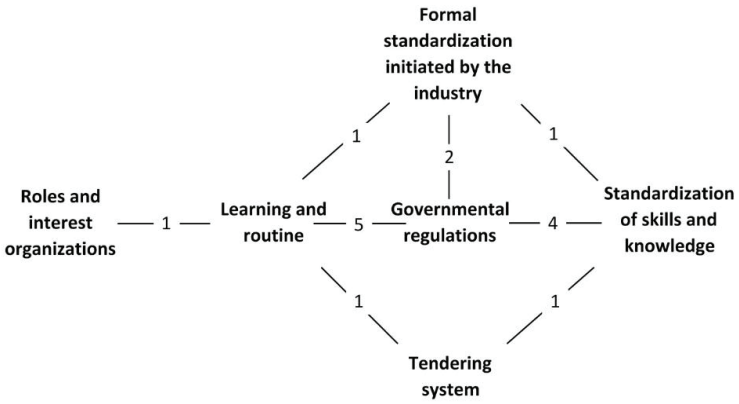

Figure 5. Building delays caused by combinations of two institutions. The numbers on the lines are the frequencies for observations (n=16).

All of the responses linked to practices characterized by two institutions were intertwined with "Governmental regulations," "Learning and routine" or "Standardization of skills and knowledge." The result is in line with the outcome of the analysis of individual institutions, in which the practices of these three institutions within the production sphere of the SHP system were found to mostly affect building project delays (Table 3). Yet, compared to the results concerning the impacts of individual institutions, in cases where multi-faceted problems were encountered, the role of purchasers' personality or personal preferences seemed to play a bigger role along with actual issues related to institutional practices. In addition, the relationships with causes and consequences seemed to be less clear, as the following quotes illustrate:

"Governmental regulations" and "Learning and routine": Respondent #59 "*Complaints and dismissals of a neighbor"* or Respondent #112 "*Inability of [community] building supervisors to collaborate."*

"Governmental regulations" and "Standardization of skills and knowledge": Respondent #7 "*An appropriate lot has not been found"* or Respondent #25 "*Finding a lot for the type of house chosen delayed the project for two months."*

All of the issues mentioned above may have been strictly related to characteristics of institutional practices. For example, in Finland, the hearing of neighbors is an official part of the building permit application process, and especially in case of deviations from the official city plan, permission from the neighbors is required (Land Use and Building Decree, 1999). Thus, challenges in the interface of "Governmental regulations" and "Learning and routine," for instance, may be caused by inflexibilities of the regulatory system or deficiencies in formal social patterns to enhance communication between different actors (e.g., detached house builder, community building supervisors and neighbors). In that case, even though the delays resulted from a combination of two types of institutions, the reasons behind them would still have been institutional ones. However, another explanation for the delays could be that the home purchasers had unrealistic preferences in terms of the characteristics and location of the house from the perspective of the city plan or neighboring milieu. In that case, the institutions would not have been the actual cause of the delays.

Similarly, the quotes linked to "Governmental regulations" and "Standardization of skills and knowledge" may illustrate either deficiencies in the norms and processes of institutions or problems caused by the house purchasers themselves. Challenges in finding a lot may have stemmed from reasons such as problems among authorities to provide land for building, which also reflects deficiencies in the processes and routines of the city planning system (production sphere in the SHP). Yet, this is not the only possible explanation – such delays may also have been caused by the purchasers' decision to choose the wrong type of house with respect to the city plan – maybe even despite the instructions given by the authorities (consumption sphere in the SHP). Thus, as a concluding remark, by employing the data of this study it is not possible to present unambiguous results on multi-institutional issues to develop detached house building processes or manage risks related to them.

6. Discussion

The purpose of this study was to address institutional practices as causes of delays on detached house building processes in the context of Finland. In all, 168 (26%) of the respondents had faced general building project delays mostly connected to building permits, finance and general life situation. In addition, from purchasers' viewpoint, practices associated with the construction sector institutions were found to be important causes of detached house building project delays (altogether 68% of the all experiences on delays) at different phases of project implementation.

From *theoretical point of view*, the identified connections between institutional structures (Kadefors, 1995) and empirical building project phases gave indications on the applicability of institutional approach in studying the detached house building within the SHP system. However, theoretical development would be needed to describe more transparently the roles of particular actors within and between specific institutions. This would allow illustrating, how different actors with their real-life practices are actually positioned in the SHP system affecting also implementation and outcomes of building processes. In this research, a preliminary examination on that was made by positioning the results in the SHP framework. In a broader context and future research, this approach might bring new avenues for analyzing the obstacles and drivers of change in the housing markets.

Based on the findings and in reference to the SHP, for homebuilder families most of the identified causes of delays were caused by institutional practices of public authorities or homebuilders' own skills within production sphere. The result on the role of public authorities in building delays indicates that the level of formality of a particular institution does not necessarily mean well-functioning institutional practices. Instead, high level of institutionalization may produce inefficiencies (see Meyer and Rowan, 1977). Compared to aspects in production, issues linked to exchange sphere played a minor role (e.g., financing for

house building). In addition, problems connected solely to consumption sphere (e.g., inability to make decisions on purchasing or unavailability of appropriate house models) were not mentioned at all.

In reference to the SHP, the results showed that in the context of Finnish detached home building processes, production and consumption spheres are closely intertwined to each other. Due to that, the usage of SHP seemed to provide useful insights on the multi-dimensional nature of institutions, practices and means affecting the detached house purchasing system especially in the context of Finland. As a difference to the speculative building processes (i.e., professional builders act as managers in the production sphere), Finnish homebuilder families have two-fold position both as customers in the consumption sphere and organizers of work in the production sphere. In order to better illustrate the fuzzy boundaries between different spheres within the SHP system, in future studies comparisons with branches of business with similar roles of clients as managers and purchasers might be useful.

Regarding *managerial implications,* an important outcome is that although the detached house building process is characterized by complexity (i.e., many issues linked to preplanning and planning, preparation and building phases), the processes handled by house building companies had functioned quite well. In all, less than 5% of delays could be identified to be caused by the companies. According to the results, the level of prefabrication did not have a statistically significant relationship with the occurrence of major building project delays. Thus, from the perspective of potential business development towards even higher levels of prefabrication, the result indicates that as such there are no special business risks related to the level of prefabrication from purchasers' point of view in relation to construction sector institutions.

Compared to industrial building processes (e.g., multi-story houses) managed by professional building developers, the detached house building processes are run by private

house purchasers usually without any professional education in construction. Moreover, since detached houses are usually built as one-off projects, purchasers do not gain any benefits from institutional accumulation of knowledge and skills. This creates a knowledge gap between different actors in the construction process and prohibits institutional practices related to "Learning and Routines" to strongly involve or evolve in the process. This is a major difference compared to other building types in the structures of housing provision and tends to decrease the quality of construction (see, e.g., Ball, 1998). To develop the project organization in the detached house business, building companies could take a bigger role as a "node" of information sharing and in diffusion of skills, such as through provision of services, which would enhance the risk management among purchasers and companies themselves. For example, if purchasers were more familiar with the bureaucracy and documentation needed during the building process along with the financial requirements and general issues related to scheduling, the processes of individual purchasers would become more predictable also from building companies' point of view.

In addition to finding individual-level solutions to manage the challenges faced by purchasers, another approach to dealing with the deficiencies in knowledge could be to develop more purposefully the business models of area construction. In that business model, a house building company takes the key role as a professional building developer to build an area of detached houses. As a result of this, there would be no need for individual purchasers to take responsibility for issues that in multi-story building projects belong to professionals. This could also lead to an increase in new types of dwellings in the markets (e.g., townhouses, which are currently uncommon in Finland). From companies' point of view, taking more responsibilities in the preplanning, planning and preparation phases would also mean more power to manage uncertainties caused by purchasers due to unrealistic or unsuccessful house design choices related to city plans, for instance. As the results concerning the impacts of two institutions on

the building project delays showed, purchasers as actors in a construction sector system may also be the actual drivers of delays, for instance in cases where they do not follow the binding norms or processes of different institutions.

If considered as obstacles within companies, especially processes and norms in "Governmental regulations" and "Standardization of skills and knowledge" may discourage the development of innovations (see, e.g., Blayse and Manley, 2004; Gibler & Tyvimaa, 2014; Lähtinen et al., 2019). However, based on the results, there are possibilities to discover new business solutions in the detached house markets by approaching from new angles the roles of different actors in the building projects.

The limitation of the study is the fact that the results of this study are based only on experiences of house purchasers in one country (Finland) in one year (2014), they provide only a limited view of the phenomena of delays caused by institutions in the detached house markets. However, the Finnish detached house markets – in which there is a rather high level of prefabrication and needs for business renewal, for instance in meeting diversifying consumer needs (e.g., Gibler & Tyvimaa, 2014) – represent a good case for obtaining preliminary insights into the potential issues to be studied in other geographic contexts. From the perspective of empirical information, in the future it would be valuable to gather comparative material from several countries to support understanding of consumer needs and challenges in different geographic areas.

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The role of municipalities in transformation towards more sustainable construction: the case of wood construction in Finland

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ABSTRACT

Transformation towards more sustainable construction calls for actions from representatives of different sectors and societal levels. Previous studies have investigated companies and national policies as promoters of change, but neglected municipalities as relevant actors. Municipalities influence construction as they are trailblazers when realizing their own building projects, as well as regulators, whose planning decisions affect local and urban development. We investigate the role of municipalities in driving sustainability transformation in construction, in particular, in relation to wood construction. The empirical study relies on data collected in Finland through a comprehensive survey among municipalities and qualitative interviews. Key factors in municipal considerations are energy efficiency and carbon neutrality goals. Regulations and norms related to construction influence municipal activities as well. We find various drivers (e.g. supportive planning) and barriers (e.g. cost concerns) to wood construction. National programmes promoting wood construction have induced gradual changes and led to some municipal pilot projects. Despite these positive examples, it seems to take time before municipalities adopt wood construction more extensively. Simultaneously, their position at the intersection of different actors and activities involved in construction provides a fruitful base for promoting sustainable construction.

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Introduction

> *For sure, it is the city that is running the show. The city has had several wood construction projects, and politics guide material choices and planning.*
> A representative of a middle-sized municipality in 2020

Societal developments and new technologies are inducing a change in construction. Importantly, ecological values are emphasized and low-carbon construction is advanced. Currently, the building and construction sector accounts for around 39% of all carbon emissions in the world (United Nations 2020a), and measures are taken to reduce this negative environmental impact, one example being the use of wood in construction. New developments concern, for instance, new business models in construction, prefabricated housing, and wood-frame multistorey construction (WMC) (Brege *et al.* 2014, Gosselin *et al.* 2017, Toppinen *et al.* 2019, Steinhardt *et al.* 2020), and citizens are also showing increasing interest in wood construction (Lähtinen *et al.* 2019, Viholainen *et al.* 2020). At the same time, associated regulations are under re-evaluation and change (de Vries and Verhagen 2016). Overall, we are witnessing political and societal pressure for more sustainable construction. However, while there may exist consensus about driving sustainability, different actors have different aims and means for action when realizing relevant changes.

We focus on environmental sustainability and our investigation of transformation in construction builds on the notion of actors being influenced by developments at multiple levels (Gluch and Svensson 2018, Toppinen *et al.* 2019). In addition, "the technical core in construction is, by definition, inter-organizational" (Bygballe *et al.* 2013), and sustainable construction calls for collaboration amongst actors representing different sectors: the public, private and third sectors. These actors enter into collaboration with participants from different backgrounds and with different agendas and goals (Fellows and Liu 2012). This forms an important premise for our study: while the key actors, such as construction companies, may aim for new

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sustainable innovations, actors representing other sectors regulate and affect their activities. Consequently, the research problem in this study is based on the question of whether the public sector actors, in particular municipalities, are actively promoting more sustainable construction and, if so, how they are doing this.

Municipal (public) authorities (representing regions, communes, and cities) are in several instances central decision-makers when it comes to construction. To start with, municipalities may lead sustainability transformation as customers, or partners in public-private-partnerships, when realizing public construction projects, thus influencing industry change and innovation as public clients (Gluch and Svensson 2018, Carbonara and Pellegrino 2020, Lindblad and Gustavsson 2021). Furthermore, construction is guided by national and local regulations, norms, and building codes, and local authorities are important decision-makers and the regulators of construction (de Vries and Verhagen 2016, Hurmekoski *et al*. 2018). For instance, zoning and city planning gives local authorities power to affect urban development (Franzini *et al*. 2018). In addition, municipalities need to put into practice the politically set targets for sustainability (Gluch and Svensson 2018). In Finland, the municipal planning monopoly, as well as local representative democracy, set a relatively strong political backdrop for the Finnish public planner in the international and even in Nordic comparison (Hytönen 2016).

This study pays particular attention to wood construction as an example of more sustainable construction. Using more wood alongside or instead of the typical materials of concrete and steel is widely advocated as a tool to advance environmental sustainability (Hurmekoski *et al*. 2015, Toppinen *et al*. 2018, 2019, Viholainen *et al*. 2021). Indeed, positive expectations related to wood construction today, as shown in the presentations of flagship multistorey buildings globally (Gosselin *et al*. 2017), in the media and public discussions (Lazarevic *et al*. 2020), and in citizen perceptions in various countries (Viholainen *et al*. 2020). These discourses highlight several positive features of wood, including the utilization of renewable resources, the speed of construction, and environmental friendliness. While some studies focus on public actors, for example, ministries—as intermediaries promoting wood construction (Vihemäki *et al*. 2020, so far, little attention has been paid to regional and local activities. Thus, while municipalities and cities are acknowledged in studies on sustainable urban development (Smedby and Neij 2013, Woolthuis *et al*. 2013), their potential role in promoting sustainability change by way of using wood in construction has not been investigated. This indicates an important gap in the existing studies. The question remains how actively and why municipal authorities promote sustainable construction.

The aim of this paper is to analyze municipalities' current role as the facilitators of transformation towards more sustainable construction. Here, *sustainable construction* denotes different actions taken to advance low-carbon or green building, where the promotion of wood construction is one potential avenue and therefore a particular focus area. The study poses the following (empirical) research questions: "What specific actions are municipalities taking concerning sustainable construction?" and in particular, "To what extent and how is wood construction promoted in the municipalities?" A description of these municipal activities contributes to the analysis of the role that municipalities (as representatives of the public sector) play in the ongoing sustainability-related societal transformation that involves construction. We take an inductive approach to the analysis and collect both quantitative data (from a telephone survey) and qualitative data (from interviews) for the study.

Our contribution is 2-fold: first, we provide a comprehensive description of municipalities' current activities related to sustainable construction and wood construction. Second, we build an analytic model where municipalities are positioned as a nexus connecting different actors involved in the promotion of sustainable construction. Their position also lies at the intersection of different multilevel forces that are influencing sustainability. As a result, we display the role that municipalities currently play in the promotion of more sustainable construction in general and wood construction in particular.

Our empirical setting builds on recent developments in one Nordic country, Finland. This national focus allows the depiction of processes taking place at different levels and across sectors within relatively set boundaries. Although we focus on one country, similar processes of promoting, for example, wood construction are ongoing globally (see, e.g. Bengtson and Håkansson 2008, Hurmekoski *et al*. 2015, Gosselin *et al*. 2017, Vihemäki *et al*. 2019, Steinhardt *et al*. 2020), and therefore, our study adds to the general understanding of transformation towards more sustainable construction.

The paper is structured as follows. We first review the literature on the construction industry under transformation and on municipalities as public

decision-makers in the field. As a result, we position municipalities in the multilevel emerging field of sustainable construction, specifically wood construction. The next section discusses the methodology for the empirical study. We then show the results of the empirical survey and interview studies. The discussion section investigates the present municipal practices in sustainable construction, in wood construction in particular, and summarizes the role of municipalities at the nexus of different actors involved in the process. We conclude with the implications of the study and potential avenues for future studies.

Literature review: transforming construction and municipalities

The construction industry under change

The grand challenge of climate change and the global trend of urbanization has led to a growing demand for climate-friendly construction. Indeed, construction and housing play a fundamental role when aiming at societal goals for sustainable development (Toppinen *et al*. 2018). The change is systemic, meaning that all entities are affected and different actors need to join forces for change. How this global and omnipresent issue is tackled depends on the construction industry, the involved actors, and their receptiveness to change.

This study relies on the concept of sustainable development and its social, environmental, and economic pillars (Elkington 1997, Hill and Bowen 1997, Goh *et al*. 2020). *Sustainable construction* thus denotes creating a built environment that incorporates actions that support the healthy and sustainable well-being of social (human), environmental and economic systems. A sustainable built environment is achieved by investing in resources and operations that have a positive and sustainable impact on these natural systems (Hill and Bowen 1997), and by adopting collaborative approaches (Smedby and Neij 2013, Lazoroska and Palm 2019). In our empirical study, we let the respondents define sustainable construction: in practice, they refer to low-carbon or green construction, and sometimes to wood construction. Consequently, we focus on environmentally sustainable construction and leave aside the social and economic aspects.

Transformation towards more sustainable construction solutions calls for innovations. However, changes in the construction sector are seen to "take a long time, due to slowly changing standards, norms, perceptions, education programmes and building culture" (Hurmekoski 2017), and the field is characterized by conservatism (Lazoroska and Palm 2019), as well as strong path dependencies and lock-in (Hurmekoski *et al*. 2015). Indeed, according to Dubois and Gadde (2002), the construction industry is a loosely coupled system in which the strong reliance on standardized components and interfaces does not foster innovation or technical development. Moreover, as noted by Gann and Salter (2000, p. 961), project-based firms in this industry "need to manage technological innovation and uncertainty across organizational boundaries, within networks of interdependent suppliers, customers, and regulatory bodies". Complex construction projects bring together a diverse range of professional experts who design, build and manage the projects and are active at different stages of the construction process (see, e.g. Slaughter 2000), thus adding to the challenges of change. Therefore, systemic change towards sustainable construction is not without problems.

The models used in discussing innovations in, for example, prefabricated housing (Steinhardt *et al*. 2020) and in project-based construction firms (Gann and Salter 2000, Bossink 2018) show different actors and knowledge flows, acknowledging government and local authorities as important actors that provide the regulatory and institutional framework for construction. Meacham and van Straalen (2018), in turn, highlighted the interactions between regulators and various stakeholders, and therefore framed the building regulatory system as a socio-technical system. We follow such lines of thinking and direct attention to the municipalities as regulators.

Regulations are an important force for change in construction. As an example, a change in the Swedish building code in 1994 allowed the use of timber as a framing material in multistorey buildings (Bengtson and Håkansson 2008, Levander *et al*. 2011), and this has led to an increase in WMC in Sweden; WMC now occurs there at a much higher tempo than in Finland, for example (Toppinen *et al*. 2019). The study by Toppinen *et al*. (2018) of the environmental concerns motivating WMC in Finland and Sweden found that the emphasis on sustainability is driven by the changing regulations (reflecting societal needs). Indeed, Giesekam *et al*. (2016) noted the need for "new regulatory drivers to complement changing attitudes if embodied carbon is to be established as a mainstream construction industry concern".

As far as companies' role in sustainability transformation is concerned, it is evident that companies are innovating and adopting new business models, as shown in the development of prefabricated housing and wooden multistorey buildings all over the world

(Gosselin *et al*. 2017, Toppinen *et al*. 2019, Steinhardt *et al*. 2020). However, studies indicate a strong path dependency regarding using well-established construction methods and materials (Viholainen *et al*. 2021). Concrete and steel are traditionally used structural materials for large-scale buildings, such as non-residential and multi-housing buildings, and while the use of wood has increased, it is still not common practice to use wood (Gosselin *et al*. 2017).

Expertise on sustainable construction is in many ways in the making, as it is a relatively new area where both regulators and companies are facing new information and demands. Bengtson and Håkansson (2008) note that wood is not a new building material, rather the question is about "reintroducing timber into construction", and yet, its adoption in the Swedish construction network was not without problems. From the perspective of adoption of new technological knowledge this change may be simple, but the existing resource interfaces influence and slow down the adoption of innovations (*ibid*.). For instance, the study by Bossink (2018) of eco-innovations in the Dutch house building industry shows that sustainable innovation creation takes place in specialized demonstration projects, but there are difficulties in the dissemination of the results to regular "business as usual" projects.

Indeed, there are many challenges in adopting new practices in construction (Brege *et al*. 2014, Steinhardt *et al*. 2020, Viholainen *et al*. 2021). Levander *et al*. (2011) analyzed industrial construction and noted the uncertainty and equivocality that both public and private business clients meet with when facing this new alternative. They see that "industrialized construction moves clients beyond their current frame of reference". Similar issues have been noted in addressing sustainability issues more generally: Quarshie *et al*. (2021) showed how individual change-makers need to tackle equivocality and uncertainty in the biodiversity protection field. All in all, previous studies show the importance of cross-sectoral collaboration and intermediates when aiming for sustainable development (see, e.g. Ritvala and Salmi 2010, Patala *et al*. 2020).

Wood construction is gaining global interest, and WMC has been widely analyzed (Gosselin *et al*. 2017, Toppinen *et al*. 2019). The interview study of Franzini *et al*. (2018) on the personal perceptions of municipal civil servants showed that WMC is considered to be an interesting and sustainable solution for improving urban citizen lifestyles. Moreover, it is seen to support local and national businesses and economies. Simultaneously, another (often intertwined) innovation concerns manufacturing off-site, also referred to as *pre-fabrication* or *industrial construction*. Industrial construction has been characterized as "disruptive innovation" (Steinhardt *et al*. 2020) and as radical change and innovation (Levander *et al*. 2011) because it can transform a complex housing product into more of a commodity product that needs less on-site production (Steinhardt *et al*. 2020). While such changes take place at the firm level and are thus outside of our study focus, they are bound to impact the connected actors in the construction network (or ecosystem) as well (Viholainen *et al*. 2021). Wood construction and prefabrication have been adopted globally but promoted to different extents in different countries. For instance, WMC is adopted in Sweden more quickly than in Finland (Toppinen *et al*. 2019), while the prefabricated housing industry in Australia and Sweden represent an early and late stage of industry emergence, respectively (Steinhardt *et al*. 2020).

To understand (sustainability-related) change in construction, several scholars use multilevel frameworks. Gluch and Svensson (2018) offered a "layered understanding on institutional work related to changes in the built environment driven by a sustainability agenda" and adopted a multilevel approach, where analysis concerns the organizational field, organization, and project levels to advance sustainability in a municipal context. Gann and Salter (2000), Bossink (2018), and Steinhardt *et al*. (2020) looked at actors representing the infrastructural framework, technological support, supply network, and projects, together with constructing firms. Bygballe and Ingemansson (2014) investigated innovation in construction by paying attention to the network of involved actors, as well as the organizational levels; they analyzed the achievement of innovations in construction using three organizational levels: project, company, and industry levels. Finally, the study by Vihemäki *et al*. (2020) on the facilitation of WMC and intermediaries also showed different actors and activities at multiple levels and focussed on, for example, ministries and organizations/programmes attending to national aspects.

The public sector and municipalities as change makers

The forces of change for sustainable construction arise from general global societal needs and developments (Whiteman *et al*. 2013), explicated and promoted by the UN Sustainable Development Goals (SDGs) (United Nations 2017, 2020b). In many countries, the state

plays an active role in promoting sustainability change in construction through legislative actions or interventions (Rasmussen *et al.* 2017). This is also the case in Finland, where the state has taken actions to advance more sustainable construction. The Ministry of the Environment published a roadmap to low-carbon construction in 2017. Furthermore, the use of wood in construction has been promoted by several governmental regimes since the mid-1990s by way of developing building codes, implementing policies, and launching various programmes (Vihemäki *et al.* 2020, Ministry of the Environment 2020a). The present government has set the goal of Finland being carbon neutral by 2035 and has the objective of reducing the carbon footprint of construction and housing (Government Programme 2019). One concrete goal set in the government programme is to double the use of wood in public construction during the government term.

Lazarevic *et al.* (2020) showed that the emergence of and innovation in WMC (since the 1990s) in Finland were mainly bolstered by national programmes. They identify two distinct periods of activity in WMC innovation, both of which were stimulated by government interventions. Vihemäki *et al.* (2020) added to the analysis by investigating organizations identified as intermediaries in industrial wood construction and in low-carbon construction. In their study, regime intermediaries turned out to be prominent actors. The focus of the study lies on ministries and national organizations or programmes, while municipalities gain less attention and are located at the outskirts of the network of actors.

The public sector has several means for advancing sustainable and green construction, including, for example, revising and simplifying regulations and building supervision, ensuring the re-education of the workforce, and launching new education programmes (Hurmekoski *et al.* 2018). Furthermore, constructive dialogue can be a tool for urban governance for sustainability as shown by Smedby and Neij (2013) in their investigation of six Swedish cities. The public sector can also promote innovations in construction, and its buying power is a factor that can support the policy initiatives of sustainable construction (Obwegeser and Müller 2018). Indeed, public clients have been identified as being of particular importance for driving change and innovation in construction (Bygballe and Ingemansson 2014, Lindblad and Gustavsson 2021), as well as local sourcing, which supports local industries (Franzini *et al.* 2018). Hynynen (2016), who discussed local and regional actors in the development of timber construction, noted that cities and municipalities can promote win–win situations as they are beneficiaries of the regionally entrenched value chains of the wood building industry.

The discussion so far shows that the advancements of sustainable construction are taking place at multiple levels—initiated by the global environmental challenges and adopted by, for example, national governments. These interlinkages and multilevel processes are also expressed by Gluch and Svensson (2018), who investigated sustainable public facilities management and noted that the need for the new practices complies with the holistic sustainability goals set by the local government, which in turn emerge from national and international sustainability targets.

Moreover, previous findings show the relevant role currently played by regulators and administrators in facilitating sustainability change. While national regulations are important, their implementation takes place locally, which shows the particular role of municipalities. Indeed, Franzini *et al.* (2018) noted that municipalities often act as important gatekeepers of urban development and construction given their authority to oversee or approve zoning and land-use plans. Municipalities are also affected and characterized by their specific features; for instance, they operate within a political context influenced by political bodies, and they need to adapt to short-term political decision-making horizons (Gluch and Svensson 2018). Previously, Vihemäki *et al.* (2020) have raised the need for understanding the regional- or local-level policy processes and the role of, for instance, city planners and architects in promoting wood construction.

We follow this advice and take municipalities to be influencers and potential change-makers in construction. The study focuses on the activities of municipal agencies that promote (or hinder) the ongoing system-wide change towards sustainable construction. It addresses an important gap in previous studies as it concentrates the analysis on municipalities, that is, on the level of regions and local actors—instead of on activities on a national scale.

To conclude, we view municipalities as a central actor in the overall transformation towards more sustainable construction. This framing builds on previous studies discussing multilevel frameworks for construction (Gluch and Svensson 2018, Vihemäki *et al.* 2020), as well as interdependencies between actors in construction (Gann and Salter 2000, Dubois and Gadde 2002, Bengtson and Håkansson 2008, Fellows and Liu 2012, Bygballe and Ingemansson 2014, Steinhardt *et al.* 2020). The field is influenced by the pressure

caused by general global societal needs and developments (Whiteman *et al*. 2013, United Nations 2017), as well as influential national policies and the public sector (Rasmussen *et al*. 2017, Vihemäki *et al*. 2020). Municipalities are one of the involved actors, being guided by national goals and interacting in the networks of local actors, including inhabitants (Lähtinen *et al*. 2019). Our contribution lies in investigating municipalities as a connecting link between national targets, and construction companies and residents, thus enhancing the target of more sustainable (low-carbon/wood) construction. This initial setting of the study brings to the fore the multiple levels of actors and activities involved in enhancing (or slowing down) more sustainable construction.

Moreover, in line with Anderson *et al*. (1998), we see that the position of an actor (here, a municipality) shows the stability dimension of networks and the role of an actor concerns the dynamic change dimension. Therefore, we will investigate municipal practices to understand how municipalities act in their role and interact in relation to the advancement of sustainable construction. Here, the term *practices* is an umbrella term for all measures that municipalities take when aiming for more sustainable construction, including, strategies and policies together with regulation and other (concrete) activities. As we see it, the field of sustainable construction (and specifically wood construction) is emerging, but for the development to gain momentum, there is a need for more data and empirical studies depicting the current situation in sustainability-oriented practices.

Methodology

Research approach

This descriptive study depicts a topical ongoing change in its focus on transformation towards more sustainable construction. With the empirical approach, we aim to reconcile conceptual work and practice (Turk and Klinc 2020). Currently, there is little knowledge about municipalities' views and activities related to the promotion of sustainable construction (both in Finland and more generally), and therefore, there is a need to attend closely to this context and allow findings to emerge from the themes inherent in empirical data. To this end, we adopt an inductive approach, and the analysis builds on a comprehensive data collection of data on municipal practices. While referring to the empirical setting of one country (Finland), we address developments that are taking place more broadly in Europe and globally (see, e.g. Bengtson and Håkansson 2008, Hurmekoski *et al*. 2015, Gosselin *et al*. 2017, Hurmekoski 2017, Viholainen *et al*. 2020).

The study relies on mixed methods and two types of data: a (telephone) survey and personal interviews conducted in 2020. The survey results provide us with a comprehensive view of the current practices of Finnish municipalities in the area of promoting sustainable construction. The interviews, in turn, provide more detailed examples of the practices and help us to understand in more depth the reasons and strategic aims that influence these practices.

The research context

Sustainable construction has been promoted in various campaigns in Finland. A notable example of a large-scale sustainability project targeted to municipalities, in particular, is the Carbon Neutral Municipalities network (called "Hinku"). It brings together municipalities that are committed to an 80% reduction in greenhouse gas emissions from 2007 levels by 2030. The network was grown from its initial five municipalities (in 2008) to include over 70 Hinku municipalities in 2020 (Carbonneutralfinland.fi 2020). Another nation-level activity supported the improvement of energy efficiency and promoted renewable energy use: the Energy Efficiency Agreement for Municipalities and the related municipal sector's energy programme 2008–2016. The essential goal of this activity was 9% energy conservation during 2008–2016, and it was targeted to small and medium-sized municipalities. When concluded, the programme had covered a total of 117 municipalities and 15 joint municipal authorities (Motiva 2020). The involvement of larger municipalities is exemplified by the voluntary climate network formed and led by the chief executives (mayors) of the six largest cities. This network, initiated in 2011, aims at versatile cooperation and aims to act as a leader in climate issues. In 2017, the cities jointly decided to increase wood construction and dedicate a specific area or target in which to increase the volume and quality of wood construction (see, e.g. City of Helsinki 2017).

When it comes to wood construction, the Ministry of the Environment has launched a national Wood Building Programme 2016–2022 for supporting the use of wood in construction and other products (Ministry of the Environment 2020a). One of the focus areas of this programme is to promote the use of wood in public buildings, and related activities include, for example, the provision of subsidies and information services to municipalities (ibid.). The share

of public construction in all new construction in Finland was 18% (i.e. 2800 million euros) in 2019. In September 2020, national targets for increasing public wood construction were launched. The target is to increase the market share of wood in all public construction from the prevailing 15–31% by the year 2022 (and to 45% by the year 2025) Ministry of the Environment 2020b). These actions have increased interest in wood construction and led to an increase in WMC. The share of completed wooden multi-storey apartments in Finland was 1% in 2010 and had increased to 10% in 2015 (Toppinen *et al*. 2018, p. 4). Despite these developments, the volumes of large-scale wood construction are still modest and WMC is still a niche undertaking (Lazarevic *et al*. 2020).

Our study focuses on Finnish municipalities. In 2020, Finland had 310 municipalities, 294 of which were located in mainland Finland. Most of the municipalities prefer to be referred to as *communes*, while 107 municipalities have chosen to use the term *town/city* to refer to themselves. Finland has nine cities with a population exceeding 100,000. Municipal local authorities have broad responsibility for the provision of basic public services to their residents; in the European context their sphere of duties is exceptionally wide and municipalities provide circa 2/3 public services in Finland. They have strong self-government based on local democracy and decision-making, and they have the right to levy taxes. The system of local authority management is characterized by division into political and professional management (Kuntaliitto 2020).

Research data

This study uses two sets of qualitative data collected in 2020: a telephone interview survey, which covered practically all Finnish municipalities, and personal face-to-face interviews with selected municipalities and companies of the construction industry field.

We first refer to the survey conducted among municipal representatives. In the study, 293 (out of a total of 294) of the mainland Finland municipalities were reached for a telephone interview. The initial list of contact information for the sample came from the database managed by a research company "Rakennustutkimus RTS Oy", which conducted the telephone interviews. This list was supplemented by information on municipalities' web pages together with the contact information provided by the municipalities reached. The survey was directed to civil servants who were responsible for construction in their municipality. The respondents were, for example, technical directors, building inspectors, or town managers. The responses thus represent the municipality as an organization and not the local politicians' views. In many cases (82 municipalities) several respondents, each representing a specific area of expertise, were involved in the interview. Table 1 shows the details of the roles of municipal civil servants included in the survey data.

Table 1. Role of the primary respondent in the survey data.

Primary* respondent	Number of respondents with this role
Building inspector	85
Technical director	60
Municipal mayor/town manager	29
Zoner, zoning manager	23
Land use manager	11
Development manager	8
City surveyor	7
Director of urban planning	6
Municipal engineer	6
Other**	58
In total***	293 responding municipalities, average interview length: 20 min.

*In 82 municipalities, two or more respondents participated in the telephone interview (35 of the additional respondents were building inspectors).
**For example, Housing manager, Municipal vitality director, Administrative director, Zoning architect, Regional architect, Land use engineer, City construction foreman, Industry director, and Civil engineering director.
***Data collection during 21.10.2020–6.11.2020. Total number of (mainland) municipalities: 294.

The survey covered different aspects of construction in the municipalities concerning three overall themes: (1) housing construction; (2) wooden apartment buildings and wood construction; and (3) business and service construction. The average interview length was ~20 min. The present study draws on the questions that concerned sustainability and specifically wood when governing construction in the municipality. These (open-ended) questions were as follows: "What kind of goals and practices does your municipality have concerning sustainable development (in construction)?" and "In your municipality, what kind of (a) enhancing factors or (b) hindering factors do you see as influencing wood construction?"

We used an open-ended format for the question to give the respondents scope to raise any topic and to mention any number of practices. This approach of using open-ended questions is in line with our inductive and descriptive approach.

The data collection took place when sustainability-related issues in construction were widely promoted in Finland (Ministry of the Environment 2020a). In 2020, these developments gained new momentum: wood construction was again emphasized in the new government programme by Prime Minister Marin

(Government Programme 2019), and in September 2020, national targets for increasing public sector wood construction were launched (Ministry of the Environment 2020b). The survey among municipalities took place immediately after this, during October–November 2020. It provided us with a comprehensive but relatively thin understanding of the municipal activities that support sustainable construction, especially wood construction.

To gain a deeper and richer understanding of municipalities' role in transforming construction, we conducted personal interviews with the representatives of selected municipalities. These interviews took place in autumn 2020, that is, in parallel with (or soon after) the telephone survey and before analyzing the survey results.

We interviewed nine civil servants, who represented seven municipalities. Our respondent selection for personal interviews was based on both intensity and different perspectives (Creswell 2013, pp. 156–158). To cover for the former aspect, we aimed for information-rich cases, that is, municipalities that we knew (based on public data) had an interest in more sustainable construction. In particular, we searched for municipalities that had promoted sustainable construction in their operations by way of, for instance, launching wood construction. This search was based on media coverage, organizational websites, or other secondary data sources, which also provided us with the contact information of suitable respondents. For the aspect of different perspectives, we approached respondents from municipalities of different sizes, from large cities, through medium-sized towns to a very small town. Convenience sampling (Creswell 2013, p. 157) describes best our sampling strategy because we approached municipalities and their informants based on public information showing promotion of wood construction.

Different perspectives were also offered by the views gained from companies representing construction and the private sector. We rely on five interviews with company representatives conducted (mainly) in summer 2020. The respondents represent a construction company, an element producer, and three actors that are involved in the design phase of construction projects, namely two architects and one structural engineer. These interviews helped us to understand how other parties of construction networks perceive the municipalities' activities in construction. Tables 2 and 3 show the details of the personal interview data sources. When illustrating the respondents' views in our study through quotes, we also name the background of the respondent (size of the municipality or type of firm) to contextualize the comments. Otherwise, the respondents are kept anonymous.

The personal interviews focussed on wood construction as a concrete example of advancing more sustainable construction. The civil servants were asked to provide a brief description of how sustainable construction, especially wood construction is promoted in their municipality and the reasons for these activities. Therefore, these interviews form mini-cases of different municipalities. We gained supplementary information by following webinars, which showed additional concrete cases of wood construction in these or other

Table 2. Interviews with representatives of municipalities (public sector).

Type/size of municipality	Job title	Interview date (and length)
Large city	Planning engineer (Central administration)	26.11.2020 (55 min)
Large city	City architect	26.5.2020 (51 min)
Medium-sized town	Development manager	27.10.2020 (55 min)
Small town	Development director	10.11.2020 (60 min)
	Development manager	11.11.2020 (35 min)
Small town	Trade ombudsman	16.12.2020 (58 min)
Small town	Technical director	16.12.2020 (30 min)
	Business advisor	16.12.2020 (50 min)
Very small town	Chief executive	5.11.2020 (30 min)

Large city > 100,000, Medium-sized town 20,000–100,000, small town 10,000–20,000, very small town < 10,000.
In 2019, Finland had 5.5 million inhabitants and 311 municipalities. The average number of inhabitants being 17,766 (median 6066). Source: Kuntaliitto 2020.

Table 3. Interviews with companies (private sector).

Type of organisation (role in a construction project)	Job title	Interview date (and length)
Architect (design)	Architect	15.6.2020 (55 min)
Architect (design)	Architect	18.11.2020 (30 min)
Structural engineer (design)	Unit director	27.5.2020 (52 min)
Constructor	CEO	14.8.2020 (55 min)
Element producer	CEO	19.5.2020 (60 min)

municipalities or discussed sustainable construction issues.

All the respondents whom we approached replied positively to our request for an interview. The interviews were personal one-to-one meetings organized (due to practical reasons caused by COVID-19) online (*via* Zoom or Teams). We posed open-ended questions using a thematic interview guide, which included, for instance, the following questions: How does your municipality support and realize wood construction? What are the most important barriers to wood construction? Where, when, and why are wood projects realized? How do the national targets for wood construction impact your municipality? The full list of interview questions posed to the municipal respondents is presented in Appendix 1. The interviews with the company representatives followed these lines, but were more general, discussing sustainable construction, wood construction, and the roles of different actors in construction.

Analysis

The survey data is analyzed descriptively to provide an understanding of the current state (in the year 2020) in municipalities regarding their practices related to sustainable construction, especially wood construction. Thematic coding was used as the primary tool for the analysis of the interview transcripts and the open-ended replies to the survey. In this way, we (manually) aggregated the single replies into themes that are presented later. To provide an example of our coding, replies, such as "the building inspection aims to encourage new home builders to invest in energy efficiency", "wise use of energy" and "savings in energy use" formed the theme "Energy efficiency". In turn, the theme "Building according to rules and regulations" included such comments as "norms are followed", "regulations are followed" and "we take measures that are required by law". The theme "Strategic level carbon-neutral initiatives" included responses that emphasize sustainability in a strategic context, such as "we have formed a group to start renewing city's climate strategy"; "the city has a sustainability strategy"; "carbon neutral initiatives are noted in the city strategy"; and "a project plan on sustainable development is under way". We counted the codes and present them in the results of the survey to better indicate current municipal practices, although we primarily approach the data from a qualitative standpoint (cf. Creswell 2013, p. 185).

Our analysis of the personal, face-to-face interviews relies on finding concrete practices adopted for promoting sustainable or wood construction. We look for themes arising from the interview data. The interviews are an important addition to the survey analysis because they provide an opportunity to understand the adopted practices and strategies in more detail, as well as to elaborate on the reasons for their adoption. Furthermore, the company responses portray how external actors see the role played by municipalities in sustainable construction today.

The validity of our findings is shown in that they in many respects correspond with other studies discussing, for instance, views on WMC or barriers to wood construction. In addition, we have discussed the results with representatives of the construction industry and municipalities in, for example, webinars, and found confirmation from them. Our study points to some novel aspects as well, for instance, the need for contextual analysis, and this provides room for future studies. The study is limited to one country, but thanks to this choice, we can reach a comprehensive data set on the municipalities.

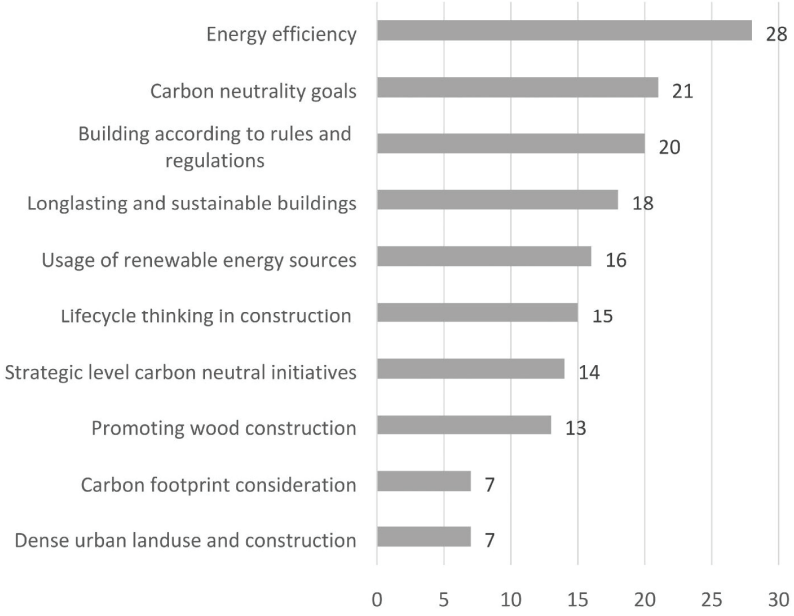
Results

Sustainable construction in Finnish municipalities

The results of the survey provide an overall understanding of how Finnish municipalities address sustainable construction. Most of them have goals and practices related to enhancing sustainable construction. The representatives of 166 municipalities (that is, 57% of the municipalities) replied to our first question: What kind of goals and practices does your municipality have concerning sustainable development (in construction)? The rest of the municipalities, 127, told us that they did not have any practices related to sustainable construction or at least no notable practices. The respondents could mention any number of practices, and we received 288 comments in total. The responses were grouped into aggregated themes, as shown in Table 4.

Among the actions related to sustainable development, the most commonly mentioned was "energy efficiency": 28 municipalities (that is, 17% of those having any practices) took up this topic. Twenty-one municipalities noted "carbon neutrality goals" and 13 of these particularly mentioned Hinku, the joint activity of the Carbon Neutral Community Network (Carbonneutralfinland.fi 2020). The point of "building according to norms and legal regulations" was raised by 20 municipalities. Potentially, such replies are due

Table 4. Sustainable development practices in construction in municipalities in 2020 ($n = 166$), number of respondents raising the theme.



to the recent or emerging regulations, or awareness of the national targets for wood construction, which had just been launched. On top of the list were also such topics as "long-lasting and sustainable buildings" and "renewable energy sources". Thirteen municipalities (8% of the respondents) paid attention to the promotion of wood construction.

To conclude, energy efficiency issues dominate in municipal work, which is probably due to the previous national programmes on the topic. Municipalities emphasize long-lasting and sustainable buildings, indicating also the relevance of PPP projects. However, attention to life cycle thinking is still relatively scarce, although the first versions of a national method for the whole-life carbon assessment of buildings (Ministry of the Environment 2019) have been presented. The data shows that Finnish municipalities are taking some steps towards more sustainable construction. Wood construction gains attention but still plays a marginal role in municipal activities.

Views on the drivers and barriers to wood construction

To delve into wood construction in more depth, the survey posed a question about the drivers and barriers that influence wood construction in municipalities: In your municipality, what kind of (a) enhancing factors or (b) hindering factors do you see as influencing wood construction?

We look first into the hindering factors to see what kind of hurdles need to be overcome before wood construction becomes more popular in Finland. Markedly, the majority (i.e. 191 municipalities—65% of all Finnish municipalities) informed us that there were no hinderances to wood construction.

Ninety-seven municipalities discussed some hindering factors. As Table 5 shows, the most important factor hampering wood construction was the question of cost and expenses—this was mentioned by 24 municipal representatives. Essentially, wood construction was perceived as an expensive way of constructing: this was particularly mentioned in connection with large buildings and when compared with using typical concrete in construction. Another concern (getting 13 responses) was related to the poor economic situation of municipalities, and in connection to this, some respondents also mentioned the COVID-19 pandemic as having a negative impact. Twelve respondents pointed to the prevailing traditions in construction which hinder new ways of construction, and 10 raised the issue of (restricting) building regulations. Respondents' comments on prevailing negative attitudes (or even prejudices), limited supplies, and a lack of skills seem to characterize the perceived state of

the wood construction industry: there is a need to gather both experiences and knowledge to advance the wider adoption of wood.

When turning to the drivers of wood construction, we find a very positive approach to wood construction (please see Table 6 for the responses related to the drivers). Only 55 (19%) of the municipalities found no factors for promoting wood construction. The foremost driver for wood construction is land-use planning and zoning; this was mentioned by 40 municipalities (14% of all the Finnish municipalities). The municipalities may permit wood construction, or they may direct construction towards wood construction through stipulations. These different perspectives are shown in the following responses:

> *In one planning project, we have considered enhancing wood construction and wooden multistorey buildings in particular.*

> *We prescribe wood construction in this particular zoning area.*

Table 5. Barriers to wood construction in municipalities in 2020, number of respondents raising the theme.

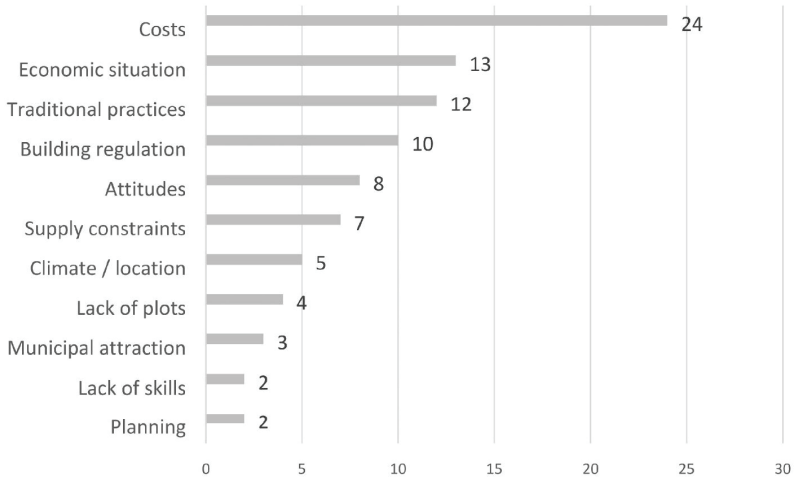
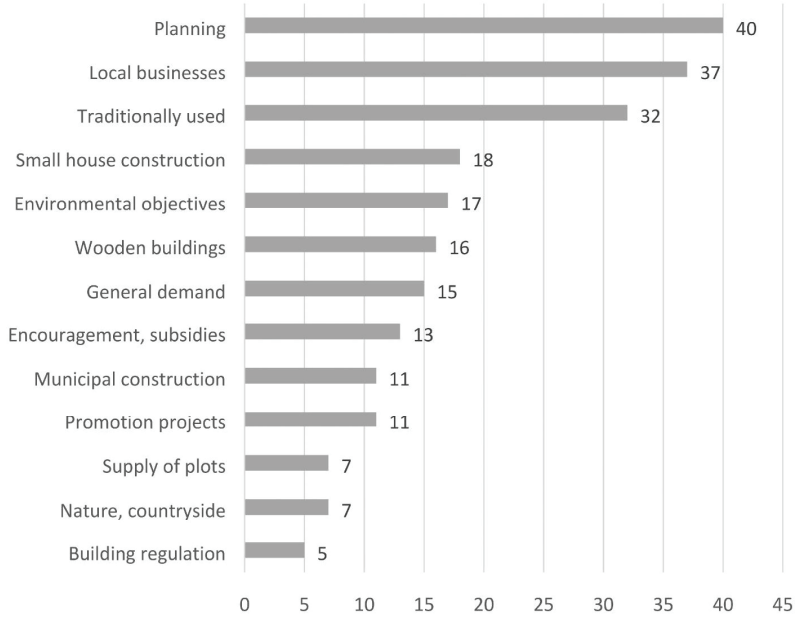


Table 6. Drivers for wood construction in municipalities in 2020, number of respondents raising the theme.



Another notable factor mentioned was the role of local actors, such as construction companies or material suppliers, indicating municipalities' interest in building on and supporting local resources. Several municipalities emphasized industrial policy and local actors in promoting wood construction. Typically, these replies concerned wood constructors, sawmills, or the forest sector in general, as shown in the following:

> *There is a factory that manufactures houses nearby.*
>
> *There is a goal of maintaining jobs through wood construction.*

The third factor enhancing wood construction pointed to the existing traditions, as noted by 32 (11%) of the municipalities. Here, the respondents mentioned in particular that small-scale, detached wooden houses have traditionally dominated buildings in Finland. Many respondents noted that wood was currently the dominant building material or referred to the existing wood buildings, as exemplified here:

> *This is a rural municipality, where the overall look encourages wood construction.*
>
> *Agriculture and forest industry dominate the municipality, and therefore, wood construction is common.*

Factors showing the influence of the developments in society at large include such drivers as environmental objectives, general demand, and subsidies or support received for wood building (these factors are all mentioned by more than ten municipalities). In addition, some municipalities actively run their own construction and promotion projects.

All in all, when investigating these impeding and enhancing factors, we find that they comply with typical views presented, for instance, in the webinars of the field, and they indicate a slow pace of change in the field—attitudes, and practices change slowly and actors stick with the prevailing or traditional ways of running municipal construction. The comments given by the respondents in the telephone interviews were relatively brief while longer elaborations and more contextual understanding were received in the personal interviews that are discussed next.

The experiences of municipalities and firms related to wood and sustainable construction

Our personal interviews with the representatives of **seven municipalities** show the public sector work for sustainable construction in more detail. Several respondents noted that sustainability issues were, in one way or another, included in the municipal strategies. In the following case, the municipality linked construction to its critical strategic areas of growth and sustainability:

> *Our strategy notes that the municipality should grow. […] And then, we have these targets related to the environment and sustainability. And there too, this construction side is one important area. In a similar vein, perhaps, higher usage rate of premises could be one area [of promoting sustainability]. That is, to not build so much and, rather, to build less and to build with higher quality.* (a representative of a small town)

Evidently, the focus lies on decreasing carbon emissions and energy savings while only some municipalities see wood construction as a tool for sustainable construction, as exemplified in the following views:

> *We are currently drawing an action plan for low carbon operations. And we have, for instance, a team working on energy savings.* (a representative of a small town)
>
> *If you consider the strategic targets of the city, today they note that the city should be carbon neutral by 2030 and there is a programme for energy and climate.* (a representative of a medium-sized town)
>
> *Our city has now made several decisions on increasing wood construction and promoting the use of wood as a building material. So, I follow this and try to promote this or to at least make these advancements possible.* (a representative of a large city)

Large-scale wood construction in particular was seen to be a novelty. So far, the municipalities had typically only realized smaller wood buildings. Indeed, the tradition of wood construction is visible, but the municipalities are still hesitant about realizing large-scale wood construction:

> *Large-scale wood construction – it is in my view a fairly new thing. In addition, legislation in Finland has perhaps hindered building multistorey wood buildings. Nevertheless, wood construction itself is not anything new, we have strong traditions of wood construction [in the region].* (a representative of a small town)
>
> *We primarily have these smaller buildings because schools, day-care centres and those sorts of projects are largely made of wood … being traditionally locally built. So, we do not have massive wood or CLT [cross-laminated timber] or anything like that. […] For instance, we do not have any special zoning for or requirement for using wood there. […] so, we have not in any way supported or particularly emphasised [wood building]. We have considered it, probably euros have been our consultants; that is, we have not been ready to pay more for massive wood.* (a representative of a small town)

Indeed, wood construction was often perceived to be an expensive option. When the municipality had

received project support from the Ministry of the Environment (through the Wood Building Project, Ministry of the Environment 2020b), we asked explicitly about the importance of this endorsement. It seems that this governmental funding, while not launching new activities, speeded up many processes. As noted by two respondents:

> *I believe it was fairly important [for the municipality] to venture to test this [multistorey wood building]. It is anyway a new concept, so I suppose [the funding] was a pushing force in the end. This will now be realised within a shorter schedule. I believe though that this would have been accomplished anyway, but it could have taken more time.* (a representative of a small town)

> *We have started a project on multistorey wood building, it will be used as a pilot. A critical factor is to get governmental financial support.* (a representative of a medium-sized town)

Another response to our question about whether the municipality would have started their wood building project without the support from the Ministry of the Environment shows not only the importance of the funding but also its role in raising new ideas:

> *I do not believe [we would have started it] or at least it would have required a lot. … This building, once realised, probably raises new thoughts.* (a representative of a medium-sized town)

In fact, the role of the Ministry of the Environment as a promoter of wood construction was noted in several ways. One of the respondents noted that the city had received good instructions on how to write a funding application, and another commented on the importance of having a personal contact in the ministry. However, the national targets for wood construction (launched in September 2020) had not (yet) had any notable effect, as seen in the following views:

> *I find that having a personal contact has been helpful. […] The Ministry representatives have their own pressures to create jobs and possibilities. In my view, our cooperation has gone well. The Ministry is not [bureaucratic], at least not in my view; sometimes people have the impression that ministries are so theoretical.* (a representative of a small town)

> So far *[the national targets for wood construction] have not really had an influence, at least not here.* (a representative of a small town)

The importance of the local issues, businesses, and conditions (e.g. the local construction industry) noted in the survey came through in the interviews as well. If there is, for example, a wood industry close by, the municipality itself is motivated to promote wood buildings. Indeed, the local industry structure is a critical factor and in some cases, the municipality raised the need for being unbiased in its supportive actions:

> *We have local production of concrete elements and steel structures, as well as glass-aluminium production. In addition, we even have production of wood buildings. … So, we have production of all materials in this area. … Therefore, it is hard to favour any of them.* (a representative of a small town)

In regard to external stakeholders, one municipality notes the involvement of citizens and engagement in dialogue with the stakeholders:

> *When the energy and climate programme was created, we relied on interaction. We cooperated with different experts from the university and we engaged citizens too.* (a representative of a middle-sized town)

When asked about interaction within their own organization, the respondents brought up both hindering and promoting factors in relation to sustainability. Collaboration across functions and units internally may work well or impede sustainability work, as exemplified in the following:

> *If we take, for instance, the technical sector [within the city organisation] – because it is the most central for construction – they operate in long-standing historic silos … there is internal competition for funding and resources, and this impedes sensible actions.* (a representative of a middle-sized town)

> *We had active planners [in zoning] who wanted this but did not really manage to go further. It was really like piloting in nature –some small [projects] here and there. But then we got these climate targets, where wood construction was one of the measures. … In addition, we have now this climate team.* (a representative of a large city)

While the respondents noted different actors' role in wood construction, the emerging overall picture gives the municipality a key role in influencing how construction develops, with linkages to local politics as well. On wood construction, one city representative noted the key role of politicians in influencing planning and commented:

> *For sure, it is the city that is running the show. The city has had several wood construction projects and politics guide material choices and planning. In particular, the Green council group is the biggest [in politics] and their representatives are very active in the city planning committee.* (a representative of a large city)

To understand the role of municipalities in the sphere of wood construction activities, we also address firms' perceptions. Our **interviews with the five firms** confirm the key role played by municipalities in promoting wood construction by both offering

support to businesses and being a client, as well as forming partnerships with the construction companies:

> *The municipality wants to promote regional wood constructors; for instance, it organised a trip to Kiruna in Sweden to see if someone would manage to create contacts there as they are relocating the entire town there. All the [local] wood building manufacturers went along. The municipality supports everyone and has meetings where all companies are gathered, and tries to promote [business].* (an element manufacturer)

> *Public construction (e.g. health care centres, senior homes, schools, etc.) is driving the market at the moment.* (a CLT manufacturer)

> *And Tampere has proclaimed itself as a city of wooden (multistorey) blocks. In this way these partnerships – in student housing – in almost all cities have awakened. (a constructor)*

One company acknowledges the critical influence of municipalities but also emphasizes the responsibilities of constructors. Accordingly, companies need to develop and provide competitive wood products to the markets:

> *Cities play a big role, starting from zoning and all … The city has acted in an exemplary way in these developments. Now we have cooperated in the zoning of one target close by to here. … This zoning [planning] side is important. A counterargument that I have used when defending wood construction is that we cannot take it for granted that here is an area zoned for wooden blocks and that no one can come and build something else. … In my view, this is the wrong way to go because one must make this product and make this way of constructing both competitive and a concept that works in free markets.* (a constructor)

Several interviewees emphasized the role of decision-making and collaboration in the early phases of construction projects. The idea of using wood may be present early on, but discussions with, for example, structural engineers and architects are needed to develop the idea into a concrete product and building. Good planning is central for a successful wood project, and again, the influence of politics and the need for more information is present, as seen in these quotes:

> *We structural engineers plan for the unit person who starts a construction project – for instance, a public sector representative, like a representative of a town or municipality … We provide alternatives; one is usually seeking the most economically advantageous or safest solution, and for us, different materials are equal in this. In this sense, we are independent consultants and we only consider the technical and economic issues. These political issues do not influence us. If a municipality is a constructor and they have a manufacturer of certain products in their area, they may want to use those products and press or recommend using a certain material. … They usually have something related to their culture, personnel or skills, and we need to support it, act accordingly.* (a structural engineer)

> *The buyer (the orderer) should have a crystal-clear target regarding what they are aiming for with this. … Today, if it happens that the buyer sort of has an idea that it would be nice to use wood but does not really know a lot about it, then it largely falls to the designer to give information to the buyer.* (an architect)

The responses from the municipal actors showed that the national targets (launched in 2020) for public wood construction have not yet influenced the market. The governmental and municipal targets for carbon neutrality are, however, carefully followed and will cause changes in the future. This is seen, for instance, in the following response, elicited when an element manufacturer was asked whether municipal targets for carbon neutrality are visible in wood construction:

> *Not yet, but they will be visible soon for sure. Finland has decided to be carbon neutral by 2035, and the city wanted to go further and announced that it will be carbon neutral by the year 2030. For us, because the city forms a large market, this would mean the carbon neutrality would influence us. But we do not know yet how it is calculated because the regulations have not yet been nailed down.* (an element manufacturer)

Municipalities as the promoters of wood construction

Drawing on our empirical findings, we investigate the role of a municipality at the nexus of different actors and as a promoter of sustainable construction, in particular wood construction. We see that municipalities are embedded in a network, which includes different actors involved in construction, and they interact with actors representing various sectors. Furthermore, they operate at the intersection of different expectations and demands for sustainable construction, especially wood construction. This analytical frame is presented in Figure 1. We analyze which actors are most relevant when the municipality acts on sustainability issues (actors are shown as circles in the figure) and discuss the interaction between the actors (indicated by the arrows).

The network includes the state as a governing actor who provides the legal rules and norms for municipal behaviour. Increasingly, governmental guidance is given in the form of different programmes aimed at more sustainable construction and/or wood

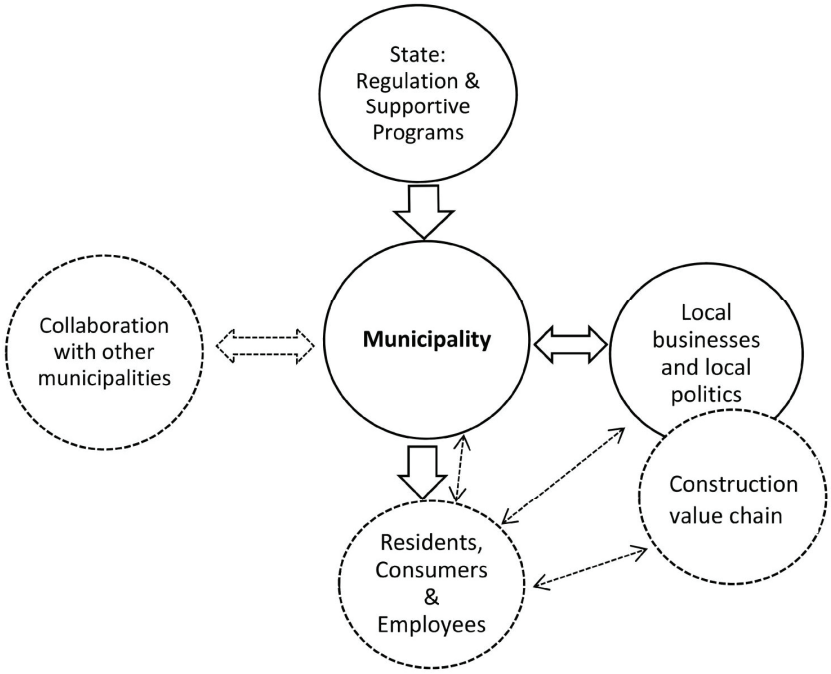


Figure 1. Municipalities at the intersection of different actors and activities in promoting sustainable (low-carbon/wood) construction.

construction, and such programmes have previously been shown to be important intermediates in the field (Lazarevic *et al.* 2020, Vihemäki *et al.* 2020). In our study, some, but only a few, exemplary cases of initiating wood construction projects as a consequence of governmental support were raised.

We mainly find a one-directional influence from the state as municipalities followed the given norms and rules. The figure denotes such regulation from state to municipalities by a solid-lined arrow. However, in cases where some special projects had received funding from, for example, the Wood Building Programme (Ministry of the Environment 2020a), more intensive interaction took place between the parties. Several municipalities also commented positively on the guidance and help received from the ministry representatives. This implies that networking and learning processes are taking place between the intermediaries (cf. Vihemäki *et al.* 2020).

The municipalities themselves emphasize the role of local businesses and industrial policies in their decision-making. While municipalities are willing to build on local resources (Hynynen 2016), they need to consider local businesses broadly and impartially. Several municipalities explicitly referred to companies representing the construction field; companies belonging to wood construction value chains were given particular support if they were sole businesses in the region. The figure illustrates this by connecting the local businesses and the wood construction value chain.

Some cooperation between municipalities takes place in the promotion of carbon-neutral or wood construction (e.g. within the Hinku network). This implies that networking and learning processes are taking place between the intermediaries (cf. Vihemäki *et al.* 2020). Here, such relationships connecting municipalities were not explicitly addressed. We note, however, this potential activity with the dashed arrow joining municipalities because such cooperation has been discussed in other contexts and the secondary data, and we expect it to increase in the future. The value of such relationship building and information sharing has also been indicated in the study by Smedby and Neij (2013) of collaborative and integrated urban governance for a sustainable built environment.

Finally, the influence of residents and consumers was commented about in generic terms; their role was implicitly presented in, for example, the municipalities' aims for providing good living conditions for the residents. This is in line with the study by Franzini *et al.* (2018), where civil servants perceived WMC as a

solution for higher-quality construction and improved quality-of-life aspects for end users. Furthermore, one example of the engagement of residents in the development of a carbon-neutral town strategy was presented. Obviously, municipalities' actions related to construction will eventually also influence residents (depicted by the one-directional arrow in Figure 1). The study by Toppinen *et al.* (2018) on WMC showed that the sustainability topic is driven by changing regulations (reflecting societal needs) rather than consumer needs. We expect that in the future, citizens will be more active in demanding wood buildings and putting pressure on construction companies, as well as on local politicians, given the recent positive citizen attitudes towards wood construction (Viholainen *et al.* 2020). This potential influence is indicated by the dashed arrows in Figure 1.

In addition to analyzing the position of municipalities in the sustainable construction network, we investigate their role there (Anderson *et al.* 1998) by looking into their actions and practices (as presented in the survey and interviews) in more detail. Interestingly, on some issues, the municipality can be seen to play the role of an enabler as well as an inhibitor. For instance, the municipalities reported the use of planning and zoning as vehicles to promote a certain type of construction. Simultaneously, some respondents referred to there still being too many restrictions on zoning as forming a barrier to wood construction. Another ambivalent theme was that of traditions: on the one hand, traditions were presented as a natural base for wood construction since wood has been extensively used, in particular, in smaller detached houses. On the other hand, the respondents noted that the long tradition of and skills in building with concrete or steel makes a transformation to wood difficult.

Municipalities' activities that boost wood construction are still relatively modest. Large cities have been more proactive and taken wood construction into their agendas. Examples include, for instance: Tampere, which aims to be the leading city in wood (Tampere 2020); Helsinki, which has included an increase of wood construction in its strategies (City of Helsinki 2017); and Jyväskylä and Joensuu, which have supported the building of multistorey wood buildings. Tampere was a forerunner in zoning a city block for WMC, in which the first WMC with eight floors in Finland was raised in 2015 (Puuinfo 2020), and Joensuu boasts about the internationally recognized tallest all-wood building in the world: a 12-storey apartment building (National Geographic 2020). Activities of such committed municipalities (as well as some included in our interviews) are similar to the activities of intermediaries promoting wood construction nationally.

Discussion

This study sheds new light on municipalities' role as the facilitators of transformation towards more sustainable construction. It has adopted a multilevel perspective to study the transformation, thus following the lines of some previous studies (Gluch and Svensson 2018, Vihemäki *et al.* 2019, Lazarevic *et al.* 2020). The analysis started by delineating the position of municipalities in such a multilevel system. From this rough base categorization, we moved on to analyzing municipalities and their context. Our key contributions are the comprehensive description of municipalities' current activities related to wood construction in particular and the analytic model showing the position of municipalities as a nexus connecting different actors in sustainable construction (see Figure 1). Our study took place in a setting where pressures for more sustainable construction appeared at different societal levels. A case in point is formed by the UN SDGs, which pave the way for a more sustainable future, as well as underscore the need for timely data with which to measure progress and inform decision-making (United Nations 2017, p. 2). With its empirical focus, this research aims to contribute to such an information base, in particular, in relation to wood construction.

The strength of this study is that it provides a comprehensive view of current practices in Finnish municipalities, thus addressing the need for quantitative studies and surveys with good coverage to complete previous interview studies (Franzini *et al.* 2018). The findings show that almost 60% of the municipalities had practices targeting sustainable construction, and typically, the municipalities aimed for energy efficiency and carbon neutrality. Our focus on wood construction contributes to the literature on material-based sustainability transition in construction (Viholainen *et al.* 2021). The study notes similar barriers to the adoption of alternative materials (such as wood) as those found in the study by Giesekam *et al.* (2016). While 65% of the municipalities replied that there were no hindrances for wood construction, only 13 municipalities paid specific attention to the promotion of wood construction.

The survey data showed various drivers (e.g. supportive planning and the recognition of local businesses) and inhibiting factors (e.g. price and economic

considerations, as well as the customs of construction) influencing the use of wood in municipal construction. These findings were aligned with the views expressed in the interviews and with previous studies on the individual perceptions of municipal civil servants (Franzini *et al*. 2018). The themes emerging from the data were largely the same topics that have been present in media and public discourses, as well as in previous studies on, for example, motivators and barriers for wood construction (Gosselin *et al*. 2017, Hurmekoski *et al*. 2018, Toppinen *et al*. 2019).

All in all, our results show relatively minor advancements in public wood construction so far. This finding echoes the point made by Lazarevic *et al*. (2020) that—despite a lot of media coverage, discussions on the favourable impacts of wood construction, and positive expectations—the field of wood construction still holds a niche market share. These results are in line with previous studies explicating that the construction industry is characterized by slow change processes and path dependencies (Hurmekoski *et al*. 2015, Hurmekoski 2017, Viholainen *et al*. 2021) and its move to implementation of sustainable practices in a consolidated manner has been relatively slow (Goh *et al*. 2020). Furthermore, wood construction seems to be adopted in Finland at a slower pace than, for instance, in another Nordic country Sweden (Bengtson and Håkansson 2008, Levander *et al*. 2011, Toppinen *et al*. 2019). It appears that top-down measures (regulation and support from the state) gradually trickle down to municipalities and to the construction sector, but it takes time before one sees any considerable changes in the realized volumes of wood construction.

This study highlights local conditions and the context of the municipality, which have received scarce research attention so far. The responses by municipalities to the barriers and drivers for wood construction brought forward various (network) connections, indicating the relevance of interaction and relationships with other actors when promoting sustainable construction. Such relationships or networks were not the focus of this study, but apparently, their more systematic use could provide new solutions for construction (cf. Bygballe *et al*. 2013). Furthermore, as shown in the study by Smedby and Neij (2013) of collaboration aimed at sustainability in urban development, in addition to building relationships there is an apparent need for active work to ensure mobilization around sustainability issues. Obviously, there are only a few Finnish municipalities that have been active in such mobilization to adopt wood construction on a larger scale. However, municipalities' position and role allows for significant influence on sustainable construction (cf. Anderson *et al*. 1998). Indeed, because of their position, municipalities can adopt the role of both supporting and forcing actions (cf. Bossink 2018) towards wood construction, for instance.

Municipalities' emphasis on local actors, if they belong to the wood construction value chains, is in line with the finding by Franzini *et al*. (2018) that civil servants were interested in WMC if its diffusion was seen to bring benefits to other municipal stakeholders (such as support to local industries or locally sourced wood). Similarly, Hynynen (2016) noted the connections between regional value chains and municipalities. These previous studies, together with our findings, emphasize the need for understanding local conditions and actions: municipalities are closely knit with other actors in their region, and therefore, the civil servants, as well as politicians, need to make decisions that are contextually tied to local conditions.

A key finding of our study is that municipalities have a position in the intersection of different actors and activities that allows for significant influence on sustainable construction. The numbers are still low, but in some cases, we found that the municipalities acted as promoters of sustainable construction. Some larger and committed municipalities (e.g. those of Tampere and Helsinki) seem to be taking on the intermediary role of promoting wooden construction. Consequently, their activities are similar to the ones specified by Vihemäki *et al*. (2020) for state actors, namely, the articulation of expectations and visions, building networks, engaging in learning processes, and exploration. Without a doubt, such activities are needed if the wood building is to increase and a change to more sustainable construction is to take place. Indeed, for a systemic change towards more sustainable societies, the workings of such intermediaries are crucial (Ritvala and Salmi 2010, Patala *et al*. 2020). The study by Vihemäki *et al*. (2020) focussed on ministries and state-associated agencies, and on promotional activities that had a national or regional focus. Our study has filled a gap in the literature with its focus on municipalities and local conditions.

Our findings show the key role of municipal decision-makers in regulating public construction and their role as customers (especially in the early stages of construction projects). Slaughter (2000) pointed to the different roles that companies (and individuals) can take in construction innovation as the process goes through different stages. Presumably, the public sector and municipalities may take on different roles when addressing wood construction, for example, the role of

a gatekeeper (who scans and assesses) or a champion (who encourages innovation). In essence, local politics guide construction, showing the strong linkages between politics, and social and environmental issues, and explaining variation across different municipalities.

Given the novelty of many types of sustainable construction and the prevailing uncertainty that many respondents emphasized, there is an evident need for interaction and boundary spanning across different organizations. This, in turn, calls for careful boundary management (Fellows and Liu 2012) and crossing learning boundaries (Bossink 2018). Furthermore, we show that the actors are facing uncertainty and equivocality when addressing the transformation, as previously shown in connection with construction (Levander *et al.* 2011) and sustainability (Quarshie *et al.* 2021). Apparently, more piloting and information sharing on wood construction is needed to alleviate these problems. The study by Bossink (2018) indicates that innovative knowledge in sustainability that is developed in demonstration projects tends to exclusively flow to its participating firms. Therefore, there is a need for support and force from the regulatory and institutional network to ensure dissemination of the results—here, municipalities can take a proactive role.

Because of our inductive approach, we let the respondents define sustainable construction, and consequently, the emphasis lies on environmental aspects. Municipalities elaborated very little on the social or economic dimensions of sustainable construction. A comprehensive lifecycle analysis including all three sustainability aspects, which is relevant for advancing sustainable construction (Goh *et al.* 2020), was not (yet) adopted at the municipalities. On the other hand, the results show attention on local aspects, and therefore, the strength of and opportunity for municipalities is to actively engage stakeholders and promote collaborative platforms at the project levels, which according to Goh *et al.* (2020) is another critical aspect when adopting triple bottom line in sustainable construction.

Conclusions

Sustainability concerns and climate change actions are on the agenda of decision-makers in the EU and globally. The Finnish governmental programme includes several targets for increasing sustainable construction; for instance, the Ministry of the Environment has launched a long-term wood construction programme. This has influenced regional and municipal strategy work and promoted new types of construction (e.g. types that have increased use of wood). In these ongoing processes, how municipal authorities interact with construction companies (and designers, architects, and other actors) becomes particularly important. We note that municipalities operate in interaction with different actors, representing different sectors of society, as well as at the intersection of different expectations and demands for sustainable construction (including wood construction).

Municipal authorities, therefore, act as gatekeepers who can either promote or hinder new sustainable ways of construction. We investigated the intermediary role of municipalities and showed that the local context impacts the practices of the municipality in sustainable construction. Interviewee perceptions concerning wood construction, such as quotes about the public sector "driving the market" or cities "running the show", explicate the key role played by cities and municipalities at the moment.

Our study also offers practical implications for municipalities and other actors who aim for promoting more sustainable construction. Firstly, municipalities have several means (e.g. zoning and land-use plans) for influencing construction, and their role is particularly important in the first stages of construction projects. Indeed, many of the comments made by the interviewees point to the critical role of planning and preparation in wood construction, and they deserve attention from managers and scholars in future studies. The role of municipalities is widely acknowledged by other actors, and therefore, municipalities occupy a position where they can actively promote (or hinder) sustainable construction. Secondly, there is a need for pilot projects and information sharing to reduce the prevailing uncertainty and risk aversion in relation to new solutions and wood construction. Thirdly, municipalities' responses in the study only address environmental sustainability. In the future, there is a need for a more holistic approach to sustainability (e.g. in the format of integrative life-cycle analyses) to account for the social and economic aspects as well if municipalities aim to drive the more sustainable construction that the society needs.

The focus on environmental sustainability is a limitation to our study as well. Future studies can therefore add to this by investigating the social and economic pillars of sustainability. Our framing of municipalities at the intersection of different actors and activities in relation to promoting sustainable construction (used here to frame environmental aspects) allows for such extensions as well. Another suitable avenue would be comparative studies in other

countries that would add to our single-country study. Such an investigation would help in understanding more generally how different institutional forces and conditions impact developments in sustainable construction. In addition, in-depth case studies of particular municipalities would shed more light on the local conditions and on politics—topics that arise in our study and deserve more attention.

We show that the process of moving towards more sustainable construction has started but tends to be slow. It takes time for the factors pushing from above to gain concrete results, and systemic change is not without problems. Some cities and municipalities are leading the way by realizing pilot projects. Explicating the complexities and successes in these interactions in more detail in coming studies will contribute to fostering sustainable construction in the future. Although the volumes of (public) large-scale wood construction are still low (and lagging behind in comparison with many other countries) and there remains much to do, our study shows that important developments in the areas of sustainable construction are already underway and municipalities play a critical role in this process.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix 1. Interview themes

The role of cities and other municipalities in wood (low-carbon) construction

1. Please describe your job and tasks, and how they relate to wood/low-carbon construction.
2. How does your municipality support and realize wood construction, large-scale wood construction in particular? Who supports it and how?
3. Please tell us about the history of wood/low-carbon construction in your municipality? How and when has it emerged? Why?
4. How is wood/low-carbon construction perceived/supported internally (within your municipality/across units)?
5. With whom does your municipality cooperate in this area? Which are your most important stakeholders in wood/low-carbon construction (e.g. construction companies)?
6. What kind of concrete practices do you adopt in the support of wood construction (e.g. zoning, providing lots, self-construction)?
7. What are the most important barriers for wood construction? Who or what curbs wood construction?
8. Is wood construction included in the municipal strategies? If so, how?
9. What is the role of inhabitants or consumers? How are they engaged in wood construction or urban development?
10. What is the role of local politics?
11. Please, provide examples of wood construction—where, when and why are wood construction projects realised? How do the projects develop, and how does their future look?
12. How do national targets for wood construction (e.g. the governmental programme, the national targets of the Ministry of the Environment) impact on your municipality? What kind of impact does the support (the subsidies) from the ministry have?
13. What kind of education on this topic does your municipality offer or need?
14. What kind of wishes do you have related to this matter in relation to your municipality/Finland?
15. How can the university/researchers contribute to this area?
16. Is there any other issue you would like to raise here?