

Original Research Paper

# Intermediaries to accelerate the diffusion of wooden multi-storey construction in Finland

Heini Vihemäki<sup>a,b</sup>, Anne Toppinen<sup>a,b,\*</sup>, Ritva Toivonen<sup>a,b</sup><sup>a</sup> Department of Forest Sciences, P.O. Box 27, 00014 University of Helsinki, Finland<sup>b</sup> HELSUS, P.O. Box 27, 00014 University of Helsinki, Finland

## ARTICLE INFO

**Keywords:**

Low-carbon

Materials

Market

Policy

Intermediation

Advocacy

## ABSTRACT

Intermediaries can potentially help reduce institutional lock-ins that slow down sustainability transitions by influencing policy processes, because of their connectedness and often high level of legitimacy. In this paper, we analysed intermediaries seeking to accelerate the diffusion of wooden multi-storey construction (WMC) in Finland, their roles and engagement in policy processes. Increasing the use of wood in construction has high policy support nationally, backed up with climate and forest policies. Yet, market diffusion has been slow. The data consist of qualitative interviews of intermediaries and other actors, participatory observation and a review of secondary materials. The results reveal a complex set of intermediaries, including systemic, niche and regime-based ones. The intermediaries are characterised by multiple goals, partly overlapping roles and means of policy influencing. The low degree of coordination among the intermediaries and the differences in their agenda for transition are critical challenges which limit the effectiveness of their actions.

## 1. Introduction

Sustainability transitions are fundamental, long-term changes of socio-technical systems, guided by sustainability goals and policies (Markad et al., 2016). Such transitions include the emergence of novel products, services, business models, organizations, regulations, norms and user practices, which are complementing or being substituted for existing ones. According to the multi-level perspective (Geels, 2002), socio-technical transitions (STTs) are perceived to involve contestations between emerging niche-innovations and existing socio-technical systems and regimes, also framed by broader landscape level developments (e.g. Roberts and Geels, 2019). Niche innovations represent alternative socio-technical configurations (Fuenfschilling and Truffer, 2014), but these may require decades to become mainstream due to barriers such as path dependencies and resistance from incumbents (e.g. Kant and Kanda, 2019; Köhler et al., 2019).

Intermediaries potentially play an important role in sustainability transition through facilitating and speeding up the processes involved, as suggested by Mignon and Kanda (2018) and Kivimaa et al. (2019a). However, the concept of intermediary remains contested (Moss, 2009; Kant and Kanda, 2019; Kivimaa et al., 2019a). Many definitions stress the relational work performed by intermediaries and their positioning between other actors, or even between actors and artefacts (Moss, 2009). Among the commonly agreed upon characteristics is the ability of intermediaries to work across the often-impermeable boundaries between different actor groups, arenas of action, or geographical scales. Intermediaries are seen to play an important role in connecting actors in situations in which direct interaction is challenging because of high transaction costs, communication challenges and information asymmetries

\* Corresponding author at: Department of Forest Sciences, P.O. Box 27, 00014 University of Helsinki, Finland.

E-mail addresses: [hvihemaki@gmail.com](mailto:hvihemaki@gmail.com) (H. Vihemäki), [anne.toppinen@helsinki.fi](mailto:anne.toppinen@helsinki.fi) (A. Toppinen), [ritva.toivonen@helsinki.fi](mailto:ritva.toivonen@helsinki.fi) (R. Toivonen).

<https://doi.org/10.1016/j.eist.2020.04.002>

Received 13 August 2019; Received in revised form 30 March 2020; Accepted 6 April 2020

Available online 27 April 2020

2210-4224/ © 2020 The Authors. Published by Elsevier B.V.

(Kivimaa et al., 2019a; Kanda et al., 2020).

Intermediaries may appear to be essential elements of STTs through disturbing existing structures and practices, acting in both niche creation processes and destabilization of regimes (Kivimaa, 2014). Intermediaries' roles in sustainability transitions have been studied especially in urban development, and in the building and energy sectors (Kivimaa et al., 2019a). Noting the diversity of actors and entities labelled as intermediaries, Mignon and Kanda (2018) have studied the policy implications of intermediaries of various types in the context of energy sector transition, with a focus on how the characteristics of intermediaries shape the outcomes for innovation diffusion. As pointed out by Kanda et al. (2020), intermediaries may also take a normative stance in promoting and championing certain innovations, as opposed to the neutrality seeking stance, often implied in the literature on innovation intermediaries.

So far, the efforts of intermediaries to influence policies to advance sustainability transitions have not received much scholarly attention. The previous works include a study in the UK by Smith et al. (2016) on how intermediaries associated with 'grassroots innovations' in the field of community energy have influenced national policies, building on three theoretical strains in the niche literature. Furthermore, Kivimaa and Martiskainen (2018) have analysed the policy dynamics of intermediaries supporting transition to low energy building in the UK, drawing on the transition literature. In our paper, we aim to contribute to a better understanding of how intermediaries of various types influence policies to advance sustainability and other goals, in the context of the possible sustainability transition of the construction sector to low-carbon materials.

The sustainability transition of the construction sector is of global interest as building and construction is responsible for a considerable share of energy consumption, production of carbon dioxide and other greenhouse gas (GHG) emissions and use of non-renewable natural resources (e.g. Lucon et al., 2014; Hemström et al., 2017; Huang et al., 2019). For instance, buildings are responsible for 39 % of the global emissions of carbon, based on a recent report by the *World Green Building Council* (World GBC, 2019). The proportion of emissions attributable to embodied carbon<sup>1</sup> contribute around 11 % of all global carbon emissions (World GBC, 2019). This proportion is expected to increase with reductions in the emissions caused by operational use, owing largely to reductions in the carbon intensity of the electricity supply (Ibn-Mohammed et al., 2013; Giesekam et al., 2016).

Due to deeply established behavioural patterns and persistent culture, changing the dynamics of the construction sector is not a straightforward task (Rohracher, 2001; Matinaro and Liu, 2017). It is important to acknowledge that suitability and sustainability of a material choice is highly dependent on factors specific to the site and project (Giesekam et al., 2016). Yet, choosing less emission intensive materials and materials that can store carbon such as wood, offers one potential way towards sustainability transition in the construction sector (Lehmann, 2013; Hildebrandt et al., 2017; Herajärvi, 2019). Wooden multi-storey construction (WMC) solutions, in which wood is used in the structural frames, can be an alternative for the more carbon intense technologies commonly used in multi-storey buildings (Lehmann, 2013; Hemström et al., 2017).

WMC can be viewed as an innovation in Europe and in some other regions, where these technologies imply disruptions in the markets at the macro level and discontinuities in the technology and marketing at the micro level (Mahapatra et al., 2012). However, due to several barriers, including economic, cultural and technological ones (Giesekam et al., 2016; Hemström et al., 2017), accelerating the adoption of low-carbon solutions in the construction sector, including WMC, may require significant policy action (Ibn-Mohammed et al., 2013; Vihemäki et al., 2019). So far, the social and institutional dynamics of WMC diffusion have been studied to some degree, especially in Finland and in the other Nordic countries (e.g. Hurmekoski et al., 2015; Lähtinen et al., 2019; Toppinen et al., 2019), but not from the perspective of intermediaries. Empirically, Finland is an interesting case as WMC has been high on the national policy agenda since the 1990s, and there are high expectations on the future market growth.

We seek to contribute to the growing body of research on intermediaries' roles in STTs drawing mostly from the literature on intermediaries in sustainability transitions (e.g. Kivimaa, 2014; Kivimaa and Martiskainen, 2018) and the types and characteristics of intermediaries involved (Mignon and Kanda, 2018; Kivimaa et al., 2019a). The aims are (1) to identify the types and roles of intermediaries operating in the WMC field in Finland, and (2) to contribute to our understanding on the ways in which intermediaries may influence policies to advance STTs. We address the following questions:

- Which actors and networks operate as intermediaries in WMC on a national scale?
- How do intermediaries of different types participate in the efforts to accelerate market diffusion of WMC?
- What means do they adopt to influence the policies to advance their goals?

Section 2 is a discussion of the previous literature and theorizing on intermediaries that have informed our analysis and provided the analytical framework. Section 3 describes the methods and materials as well as the case selection. Section 4 presents the results, focusing on the types of intermediaries involved, their roles and ways of influencing the policies, and interlinkages between these. Finally, in Section 5, we discuss the findings in relation to the earlier literature and make some conclusions on the future research needs.

<sup>1</sup> Emissions incurred in the building life cycle outside of its operational use, i.e. emissions associated with materials and construction processes (see Giesekam et al., 2016).

## 2. Theoretical framework

### 2.1. Intermediaries in sustainability transitions

Research on sustainability transitions has rapidly evolved in new directions within the past decade, including a better consideration of actor perspectives. Among these, the role of intermediary actors in aligning developments at niche and regime levels has been gaining attention (Köhler et al., 2019).

Our approach to intermediaries was in line with the conceptualization by Kivimaa et al. (2019a, 1072) who define transition intermediaries as “...actors and platforms that positively influence sustainability transition processes by linking actors and activities, and their related skills and resources, or by connecting transition visions and demands of networks of actors with existing regimes in order to create momentum for socio-technical system change, to create new collaborations within and across niche technologies, ideas and markets, and to disrupt dominant unsustainable socio-technical configurations”. Transition intermediaries thus cover a wide range of organizations, networks and platforms, facilitating and speeding up major shifts in the prevailing socio-technical systems<sup>2</sup>. These actions may take place in a certain field, across sectors, and in different geographic and time scales (Moss, 2009).

The roles of intermediaries in niche management, such as “nurturing” or “empowering” the niches, have been recognized as potentially important for STTs (Kemp et al., 1998; Kivimaa et al. 2014). Niches can be protected by support from suppliers, users and public policy (and the intermediaries associated with these). Among the possible public policy instruments are subsidies and favourable treatment in legal frameworks (Smith et al., 2016).

Furthermore, the dynamics between the types of intermediaries is an important aspect in transitions (and policy efforts supporting them), including potential overlaps and complementarities (c.f. Mignon and Kanda, 2018). For instance, intermediaries having similar goals can coalesce and construct narratives to draw attention and material resources to advance a niche (Smith et al., 2016; Kivimaa and Martiskainen, 2018). Niche support by intermediaries may also change over time as the transition progresses (c.f. Kivimaa et al., 2019b).

### 2.2. Classifications of intermediaries

Various classifications or typologies for intermediaries in the context of innovation systems, sustainability and urban transitions have also been created. These can be based on the functions they serve, their association or level of activity (e.g. niche, regime), or their purpose (van Lente et al., 2003; Kivimaa et al., 2019a). In their classification, Mignon and Kanda (2018) paid attention to variations in intermediaries’ sources of funding, scope of activities and (intended) targets. They suggested that variations in these key characteristics, and possibly some others, such as governance, are the key for the impacts of their activities. For instance, based on their characteristics, the intermediaries may have a short-term or long-term orientation, and focus on actor-level or system-level outcomes (Mignon and Kanda, 2018).

Kivimaa et al. (2019a) have divided transition intermediaries into five types, based on (1) context (level of action), (2) emergence, (3) goal of intermediation, and (4) normative position (including position vis à vis a niche and neutrality). Neutrality is often considered to be an important aspect in the literature on intermediaries (c.f. Kivimaa et al., 2019a). However, the degree of neutrality that intermediaries can possess if they are to speed up sustainability transitions can also be questioned, for example, due to the trade-offs between neutrality and effectiveness (cf. Kivimaa, 2014; Kivimaa et al., 2019a). For instance, intermediaries may advocate particular solutions. They may have biases because of their links to existing institutional regimes (Kivimaa et al., 2019a).

In their typology, Kivimaa et al. (2019a) identified (1) systemic; (2) regime-based; (3) niche; (4) process; and (5) user intermediaries. *Systemic intermediaries* have functions such as articulating options and demand, aligning actors and options, and supporting learning, and they often have a high degree of legitimacy (van Lente et al., 2003; Kivimaa et al., 2019a). Systemic intermediaries, often functioning at the network level, are seen to play a key role as enablers of transitions due to the complexity of innovation processes (Kant and Kanda, 2019). They may advance transitions by assisting in the renewal of the existing regime. This can occur by initiating and managing new policy or market processes and by acting as an impartial contact point or voice for new networks of actors (Kivimaa, 2014). Such intermediaries can be government-affiliated intermediaries, as in the case of Sitra<sup>3</sup> in Finland (c.f. Kivimaa, 2014).

*Regime-based transition intermediaries* form part of the established institutions of the regime but have a mandate to advance new socio-technical options. They can also work against other regime-based actors that are not supportive to a transition (Kivimaa et al., 2019a). *Niche intermediaries* can operate at the level of individual companies or projects, and across them, creating connections between them, accumulating experiences and sharing knowledge or new approaches. They can also take part in campaigning and advocating (Kivimaa et al. 2019).

*Process intermediaries* play a supporting role in the realization of specific projects within a niche or in transition processes more generally. They are typically outsiders to both niches and the regime, helping to articulate the direction of intended change, to negotiate within pilot projects or with institutional actors. Process intermediaries may help in advancing the transition by gaining the trust of other actors as being neutral, unbiased actors, as they lack a personal or institutional agenda (Kivimaa et al., 2019a).

<sup>2</sup> It should be noted that not all organizations having intermediary characteristics are involved in transition.

<sup>3</sup> Sitra (Finnish Innovation Fund) is a government-established think tank in Finland, with a mission to contribute to sustainable well-being (cf. Kivimaa, 2014).

Finally, *user intermediaries* cover organizations supporting users, with a role in connecting niche technologies to the every-day practices of the public. User intermediaries may support users in several ways, such as by helping them to adopt or apply the innovation, or to articulate their innovation needs (Mignon and Kanda, 2018). The functions (or roles) of intermediaries can also change during phases of transitions (Kivimaa et al., 2019a).

In our approach, we utilized the Kivimaa et al. (2019a) typology as the classification basis, because it distinguishes between several types of transition intermediaries based on a review of a large body of earlier research. The framework also addresses the roles that various intermediaries might have.

### 2.3. Policy influencing

Policy influencing and intermediaries can be approached from several perspectives, e.g. intermediaries' ways of influencing the policies, and how policies can be designed to enhance the effectiveness of intermediation. Regarding effectiveness of intermediation, earlier studies have analysed the policy implications of the diversity of intermediaries. The nature of intermediation may differ based on whether the organizations target the supply side, i.e. innovation developers, or the demand side, i.e. potential users (Mignon and Kanda, 2018). It has been suggested that the demand side is more relevant for policymakers interested in accelerating diffusion of innovations (Mignon and Kanda, 2018).

In the so-called niche policy advocacy approach (Smith et al., 2016), the interest is on how niches can influence the policy developments at the regime level. Targeted lobbying by intermediaries that connects the performance of a niche with the wider policy agendas of the regime is seen as a key issue that informs how niche innovations succeed (Smith et al., 2016). Intermediaries involved in a specific niche may also rely on a range of political narratives when communicating with audiences, based on the strategy they have chosen (Smith and Raven, 2012). Developing compelling, credible narratives about the performance of the niche and developing coherence in the storylines (discursive alignment) are among the steps needed. However, Smith et al. (2016) also note that the deployment of policy support and resources gained through such advocacy and discursive alignment usually do not come without conditions.

In certain conditions, such as the case of low-energy building transition in the UK, there is evidence that intermediary organizations have managed to influence policy to be more aligned with the aspirations of the intermediaries (Kivimaa and Martiskainen, 2018). In their study Kivimaa and Martiskainen (2018) identified the following ways of influencing policies by intermediaries: (1) implementing pilot projects to demonstrate what is possible and to influence *political vision building*, gradual tightening of *policy demands* (2) influencing in *standard setting and new legislation*, (3) carrying out assessments/compiling *knowledge in support of policy development*, and (4) *translating policy into practice*, (5) *creating and managing networks to lobby* for policies in favour of transition, and (6) *creating and managing public-private networks* informing the government.

### 2.4. Analytical framework

In our approach, we drew on the typology of intermediation developed by Kivimaa et al. (2019a), and combined it with the roles and ways of influencing by intermediaries identified in previous literature (e.g. Kivimaa, 2014; Smith et al., 2016; Kivimaa and Martiskainen, 2018) to analyse how intermediaries of different types participate in WMC acceleration efforts (Table 1). The typology of transition intermediaries (Kivimaa et al. (2019a), draws on the previous literature on innovation and systemic intermediaries and strategic niche management (e.g. van Lente et al., 2003; Howells, 2006). It is evident from the table that intermediaries of different types also have over-laps in their roles and activities.

## 3. Methods and materials

### 3.1. Case selection

The Finnish case is relevant as there is high national level policy interest in WMC, market potential, and little knowledge of the intermediaries involved, including their actions and roles in the acceleration. Several governmental regimes since the mid-1990s have developed building codes, implemented policies and launched programs to promote the use of wood in construction, including WMC, at the same time as providing some backup for the development of the WMC niche, (e.g. Lazarevic et al., 2019).

Approximately 95 % of the new flats constructed in Finland annually in the past few years are in buildings made with other framing materials (mostly concrete), whereas wood is the most common framing material in single and detached houses, like in some other European countries (e.g. Vihemäki et al., 2019). The market diffusion of WMC in Finland and in Northern Europe more generally has been challenged by the path-dependencies and institutional lock-ins of the risk averse concrete based construction sector (e.g. Hurmekoski et al., 2015; Hemström et al., 2017; Toppinen et al., 2019). The fragmented nature of the actor-networks in the construction sector and a lack of a shared vision for WMC among the forestry and construction sector appear as factors slowing down take-off of these technologies (Lazarevic et al., 2019).

The rapid urbanization and the increasing proportion of the population living in multi-storey buildings (e.g. Hurmekoski et al., 2015), could yet potentially create new markets for WMC. Furthermore, the importance of the forest sector in the national economy is often considered to be a justification for increased use of wood in construction in Finland (e.g. Franzini et al., 2018). In the policy debate, an association is often made between wood and increased sustainability of construction, e.g. using wood as a low carbon building material (e.g. Lazarevic et al., 2019).

**Table 1**  
Analytical framework: intermediary roles and activities associated with intermediaries. Policy influencing related activities are marked in italics.

Roles/Types	Systemic (Van Lente et al., 2003; Kivimaa, 2014; Kivimaa and Martiskainen, 2018; Kivimaa et al., 2019a)	Regime-based (Kivimaa, 2014; Kivimaa et al., 2019a)	Niche (Smith et al., 2016; Kivimaa et al., 2019a)	Process (Kivimaa et al., 2019a)	User (Kivimaa et al., 2019a)
<b>Articulation of expectations and visions</b>	<ul style="list-style-type: none"> <li>- Articulation of needs, expectations, requirements</li> <li>- Strategy development</li> <li>- Speed up application and commercialization of new technologies</li> <li>- Promotion of sustainability related aims</li> <li>- <i>Influencing political vision building</i></li> </ul>	<ul style="list-style-type: none"> <li>- Articulation of needs, expectations, requirements</li> <li>- Speed up application and commercialization of new technologies</li> <li>- Promotion of sustainability related aims</li> <li>- <i>Influencing political vision building</i></li> <li>- Aligning actors (or their interests) and options</li> <li>- Network creation, including with other types of intermediaries</li> <li>- Facilitating co-operation between actors</li> <li>- Brokering and gatekeeping</li> <li>- Finding funding</li> <li>- <i>Creating and managing public-private networks informing the government</i></li> </ul>	<ul style="list-style-type: none"> <li>- Promotion of sustainability related aims</li> <li>- <i>Influencing political vision building</i></li> <li>- <i>Aligning niche performance with prevailing policy discourses</i></li> <li>- <i>Campaigning, advocating (targeted) lobbying</i></li> <li>- Connecting experimental projects</li> <li>- Negotiating between interests and priorities to create a consolidated vision</li> <li>- Facilitating between the niche and dominant configurations</li> <li>- <i>Facilitating policy dialogue (e.g. policy forums)</i></li> <li>- <i>Creating and managing networks to lobby for transition oriented policies</i></li> </ul>	<ul style="list-style-type: none"> <li>- Assisting others in articulating the direction of change</li> <li>- Influencing political vision building</li> <li>- Developing connections between groups of actors</li> <li>- Facilitate vertical and horizontal cooperation</li> <li>- <i>Creating and managing the networks informing the government</i></li> </ul>	<ul style="list-style-type: none"> <li>- Articulating demands of the users</li> <li>- Influencing political vision building</li> <li>- Formation of knowledge-sharing networks, e.g. platforms</li> <li>- <i>Creating and managing the networks informing the government</i></li> </ul>
<b>Building of networks</b>	<ul style="list-style-type: none"> <li>- Aligning actors (or their interests) and options</li> <li>- Network creation and facilitation</li> <li>- Brokering and gatekeeping</li> <li>- Providing, managing or finding funding</li> </ul>	<ul style="list-style-type: none"> <li>- Aligning actors (or their interests) and options</li> <li>- Network creation, including with other types of intermediaries</li> <li>- Facilitating co-operation between actors</li> <li>- Brokering and gatekeeping</li> <li>- Finding funding</li> <li>- <i>Creating and managing public-private networks informing the government</i></li> </ul>	<ul style="list-style-type: none"> <li>- Connecting experimental projects</li> <li>- Negotiating between interests and priorities to create a consolidated vision</li> <li>- Facilitating between the niche and dominant configurations</li> <li>- <i>Facilitating policy dialogue (e.g. policy forums)</i></li> <li>- <i>Creating and managing networks to lobby for transition oriented policies</i></li> </ul>	<ul style="list-style-type: none"> <li>- Developing connections between groups of actors</li> <li>- Facilitate vertical and horizontal cooperation</li> <li>- <i>Creating and managing the networks informing the government</i></li> </ul>	<ul style="list-style-type: none"> <li>- Formation of knowledge-sharing networks, e.g. platforms</li> <li>- <i>Creating and managing the networks informing the government</i></li> </ul>
<b>Learning processes and exploration</b>	<ul style="list-style-type: none"> <li>- Dissemination</li> <li>- Education and training</li> <li>- Knowledge gathering, processing, generation and combination</li> <li>- Prototyping and piloting</li> <li>- Investments in new businesses</li> <li>- Advice and support (including tailor-made info)</li> <li>- Creating conditions for learning by doing and using</li> <li>- Technology assessment &amp; evaluation (for policy development)</li> <li>- Arbitration (based on neutrality, trust)</li> <li>- Seeking consensus, organizing discourse</li> <li>- Project design, management, evaluation (e.g. complex, long-term innovation projects)</li> <li>- Job creation</li> <li>- Identifying, mobilizing actors</li> <li>- <i>Policy implementation</i></li> </ul>	<ul style="list-style-type: none"> <li>- Dissemination</li> <li>- Education and training</li> <li>- Knowledge gathering, processing, generation and combination</li> <li>- Prototyping and piloting</li> <li>- Investments in new businesses</li> <li>- Advice and support</li> <li>- Creating conditions for learning by doing and using</li> <li>- Technology assessment and evaluation (for policy development)</li> <li>- Arbitration (based on neutrality, trust)</li> <li>- Policy implementation</li> <li>- Policy design</li> <li>- Policy translation</li> <li>- <i>Influencing new legislation and standard setting</i></li> </ul>	<ul style="list-style-type: none"> <li>- Dissemination</li> <li>- Knowledge gathering, processing, generation and combination</li> <li>- Prototyping and piloting</li> <li>- Advise and support</li> <li>- <i>Collecting evidence for key policy issues</i></li> </ul>	<ul style="list-style-type: none"> <li>- Dissemination</li> <li>- Advancing exchange of information</li> </ul>	<ul style="list-style-type: none"> <li>- Qualifying the characteristics and suitability of innovations for various contexts</li> <li>- Configuring innovations</li> </ul>
<b>Other roles</b>	<ul style="list-style-type: none"> <li>- Standard creation and accreditation</li> <li>- Developing shared infrastructure between projects</li> <li>- <i>Providing professional services</i></li> <li>- <i>Policy support</i></li> <li>- <i>Influencing new legislation and standard setting</i></li> </ul>	<ul style="list-style-type: none"> <li>- Standard creation and accreditation</li> <li>- Developing shared infrastructure between projects</li> <li>- <i>Providing professional services</i></li> <li>- <i>Policy support</i></li> <li>- <i>Influencing new legislation and standard setting</i></li> </ul>	<ul style="list-style-type: none"> <li>- Advancing day-to-day activities to advance transitions</li> <li>- Managing external relations of the projects</li> <li>- Brokering between different organizational or local-national priorities</li> </ul>	<ul style="list-style-type: none"> <li>- Advancing day-to-day activities to advance transitions</li> <li>- Managing external relations of the projects</li> <li>- Brokering between different organizational or local-national priorities</li> </ul>	<ul style="list-style-type: none"> <li>- Representing users at the niche-regime interfaces</li> <li>- Translating new technologies to users</li> </ul>

**Table 2**  
List of interviewees, including their position and the scope of the organization.

#	Organizational background	Position	Scope of activities (focus)
1	Ministry 1	programme director	national
2	Advocacy and interest organization (pro wood)	director	national
3	Ministry 1	advisor (material aspects)	national
4	University	professor	regional & national
5	Ministry 2	ministerial adviser, in a steering group of a national wood construction program	national
6	Ministry 3	ministerial adviser, in a steering group of a national wood construction program	national
7	Construction company (Small and Medium-sized Enterprise), WMC & other	Chief Executive Officer	regional
8	Wood construction company and building developer (Small and Medium-sized Enterprise)	vice-Chief Executive Officer	regional
9	Building sector expert organization (non-governmental, members from private and public sector)	director	national
10	Centre for Economic Development, Transport and the Environment (state associated agency, regional office)	former brand manager (wood products), network coordinator	national & regional
11	Advocacy and expert organization (pro-wood)	director	national
12	Housing Finance and Development Centre (state associated agency)	director in the area of building development	national
13	Centre for Economic Development, Transport and the Environment (state associated agency, regional office)	branch manager (wood products) / network coordinator	national & regional
14	Finnish Forest Centre (state associated agency)	project manager, regional level	regional & national
15	National Research organization	senior researcher, expert on low-carbon construction	national
16	Development company (business park)	expert on wood products, regional contact point of a wood construction related network	regional & local

### 3.2. Research approach and data

In this research we applied a qualitative approach with multiple methods, including semi-structured interviews, observation and a review of secondary materials (explained in more detail below). The early stages of research and data collection were not informed by intermediary theorizing. Rather, they built on earlier literature on WMC niche and market diffusion (e.g. [Hurmekoski et al., 2015](#); [Hemström et al., 2017](#)). A key interest was to map the actors and networks advancing WMC at the policy level. Subsequently, the focus shifted to intermediaries and their involvement. This was justified as many of the actors studied (interviewees and those discussed in the interviews) appeared to be intermediaries, based on their goals, activities and the relational nature of their work. Despite the data appearing to be useful in identifying and categorizing intermediaries active in the field of WMC, the fact that the study was not initially built on intermediary theorizing means that we may not have been able to identify all possible intermediaries operating in WMC and their actions. We recognize this as a major limitation of the study.

#### 3.2.1. Interviews

The interview data comprised sixteen semi-structured interviews of policymakers (e.g. civil servants in ministries, employees in state-associated agencies), and private sector and third sector (e.g. non-profit) actors. They were advancing WMC or wood-based materials and technologies in Finland more generally or promoted sustainability transition to low-carbon building and construction ([Table 2](#)).

A snowballing approach was used to identify the interviewees. In practice, we first approached and interviewed a few experts based on the earlier contacts some of the research team had with organizations active in promoting industrial wood construction and WMC in Finland. More potential interviewees, targeting individuals or organizations experienced in or with a (potential) role in advancing WMC in Finland were identified with the help of the first interviewees, contacts made in the wood construction related events, and a review of secondary materials (see below). The interviewees were mostly from organizations and networks operating at the national level whereas a few were from outside the capital region and from organizations (or units) with a regional or local focus. All these appeared to be relevant policy levels for WMC, as well (see [Vihemäki et al., 2019](#)).

Twelve interviewees were working for or had previously been working for organizations/networks that were identified as intermediaries in industrial wood construction or more generally in low-carbon construction. Four interviewees were not directly associated with organizations or networks acting as intermediaries. Rather, they were “stakeholders” in the sense that they were either part of the WMC industry itself or related to policy making and implementation around wood and/or sustainable, low-carbon construction. The interviews were conducted in Finnish by the first author between March and September 2018, and were mostly face-to-face, apart from one conducted through Skype.

The following themes discussed in the interviews were relevant for the purpose of this paper (and with some other themes covered in the interviews):

- goals of the organization/unit/network

**Table 3**  
List of events attended.

Event (and place)	Organizer	Date
Research seminar on WMC business aspects (Helsinki).	University of Helsinki	12.3.2018
Meeting of the Wood Finland network (Helsinki).	Ministry of Environment (National Wood Building Programme)	4.4.2018
Meeting of business development group of industrial wood construction companies (Seinäjoki).	Federation of the Finnish Wood Working Industries	20.8.2018
Wood in Construction workshop (Espoo).	Aalto university & Climate KIC EIT Nordic	8.5.2018
National Wood Day (Helsinki)	Finnish Timber Council Ltd	2.11.2018
Workshop on future export opportunities of industrial wood construction (Helsinki).	University of Helsinki	13.2.2019
Meeting of the Wood Finland network (Helsinki).	Wood Finland network coordination	8.5.2019
Meeting of the wood construction network of 6 cities (Espoo).	Aalto university, Ministry of Environment, City of Helsinki	5.6.2019

- role and activities related to promotion of wood construction (especially WMC), and/or low-carbon construction
- policy processes and programs linked to wood construction (especially WMC) and/or low carbon construction
- central actors promoting wood construction (especially WMC), and/or low-carbon construction in Finland (i.e. organizations, networks)
- counterforces, challenges operating against the increase in WMC/low-carbon construction

### 3.2.2. Other data

The interview data were complemented with a review of secondary materials, including policy documents, websites, previous research on the development and functioning of the innovation system of WMC in Finland, and grey literature (e.g. unpublished assessments). Key sources providing complementary information to the interviews included Antikainen et al. (2017); Lazarevic et al. (2019); Ministry of Economic Affairs and Employment (2014); Paavola (2019) and Rakennustutkimus RTS Oy (2018), and the websites of some of the intermediaries (e.g. the National Wood Building Programme, the Finnish Timber Council Ltd, the Finnish Forest Centre) and information sharing platforms, such as [www.biotalous.fi](http://www.biotalous.fi).

In addition, participatory observation provided additional knowledge on the goals and activities of intermediaries. The first author participated in several events, including seminars, conferences and meetings, related to sustainable construction and wood construction in Finland between March 2018 and June 2019 (Table 3). In these events, information was accumulated through listening to the speeches, taking notes, observing the participation of the actors, and the issues taken up in the public discussions.

### 3.3. Analysis

The data analysis was guided by the main research questions regarding identifying the intermediaries advancing WMC, their roles, types and means of influencing. The first task was to identify WMC related intermediaries in Finland. Of the actors interviewed and discussed in the data, intermediaries were those whose goals explicitly included development and acceleration of industrial construction and/or low-carbon construction, whose engagement in intermediation activities was related to these goals, and who allocated a considerable portion of their resources into intermediation.

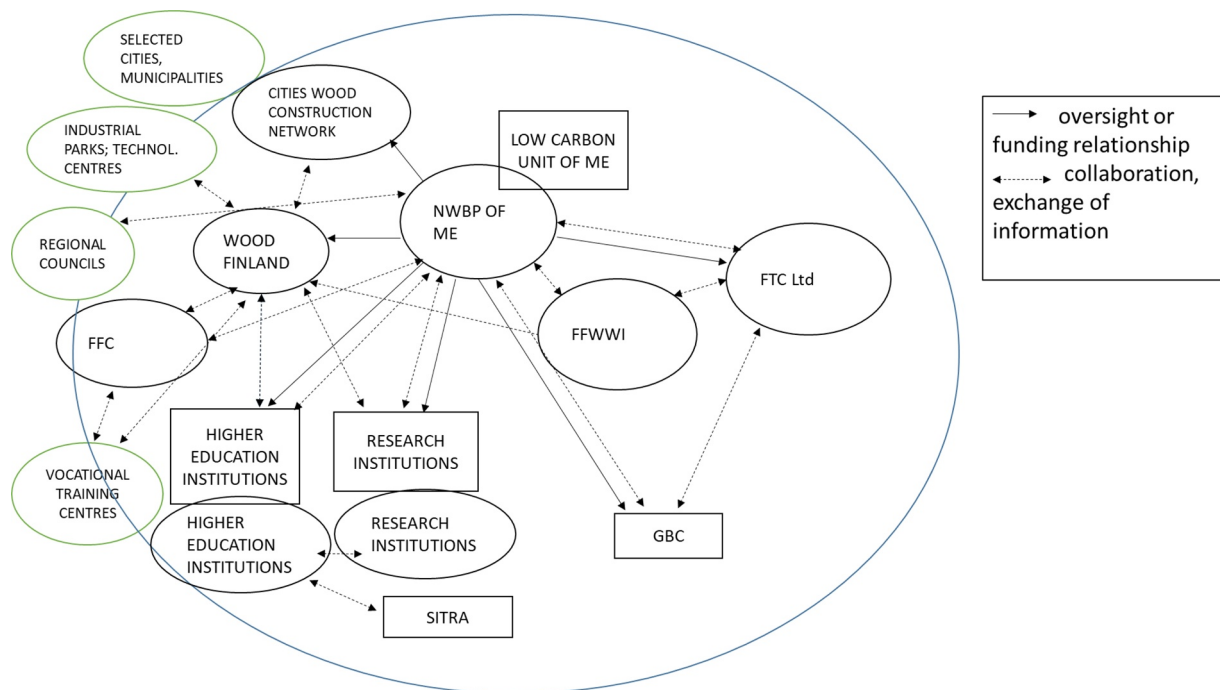
In the analysis, thematization was used. Regarding the types of intermediaries, the themes included the context in which intermediaries operate (niche/ regime/system), their emergence (established to intermediate or not), goal of intermediation (sustainability or low-carbon transition/adding value to forest sector), and the normative position (neutral/non neutral). Regarding the analysis of the roles and ways of influencing, the themes were drawn from the analytical framework (see Table 3 below). This meant matching the activities and means of influencing discussed in the interviews and in other data, with those in the framework, and then associating them with the role types. They were complemented by additional themes that emerged during the analysis.

The data collected through the interviews saturated to a large extent. However, a weakness in the data is the relatively small number of interviews, and the fact the interview themes were not formulated based on theorizing on intermediaries. This means that gaps may exist in the coverage of the roles, activities and types of intermediaries identified. However, when accompanied with the secondary materials, the findings are likely to represent an adequate body of information for the analysis of the research questions at hand.

## 4. Results

### 4.1. Intermediaries involved in the WMC field

Several intermediaries were found to be active in facilitating WMC development and diffusion on the national scale in Finland, and partly beyond. Many of them were associated with the central government and forest sector interest organizations or companies, through emergence, funding or oversight. The five key intermediaries identified were the *National Wood Building Programme* (NWBP) of the Ministry of Environment (ME), the *Wood Finland network*, the *Finnish Timber Council Ltd* (FTC), the *Federation of the Finnish Wood Working Industries* (FFWWI) and the *Finnish Forest Centre* (FFC).



**Fig. 1.** The intermediaries participating in WMC development and diffusion activities. The intermediaries marked with oval shapes are more oriented towards market growth and those in square are oriented towards broader sustainability transition. The grey circle denotes the national level vs. regional or local level focus.

These five intermediaries typically promoted wood construction as a way to increase the demand for high-value wood products, to create economic growth and employment, largely in line with national bioeconomy policy agenda (Fig. 1 and Table 4), and see also Korhonen et al. (2018). Yet, they also conceived WMC as a means to enhance climate goals in the forest sector, the construction sector, or more generally in the economy and society. This is exemplified in the interview of a representative of a public sector organization (I13): “If there was a shift towards constructing more with wood, the climate advantages would be evident”.

The intermediaries associated with the central government were connected through funding and oversight to three ministries, including ME, the Ministry of Employment and Economic Affairs (MEEA), and the Ministry of Agriculture and Forestry (MAF), see also Table 4. These intermediaries included: (1) the NWBP, coordinated by ME; (2) the Wood Finland network, connected organizationally with MEEA and through funding with ME; and (3) the Finnish Forest Centre, linked to MAF<sup>4</sup> through strategic guidance.

The NWBP, Wood Finland network and FFC through its regional programs filled many characteristics of regime-based intermediaries (e.g. mandated by the government, being outsider to WMC niche, regarded as part of the dominant system). The NWBP and Wood Finland were temporally relatively short lived and their funding that was tied to the timeframes of government regimes. FFC intermediation was largely dependent on project funding.

The coordination unit of the NWBP was identified as the most central intermediary in WMC from the government side. It was connected with the construction and forest regimes and established in 2016 to advance industrial wood construction in support of the national bioeconomy strategy. It also had close linkages to the government’s climate agenda: some of the activities falling under the NWBP were directed to supporting transition towards low carbon construction (I1, I2).

The NWBP also collaborated with another initiative of the ME, which was promoting transition to low-carbon construction (e.g. through testing of European indicators). The connection of wood construction with low-carbon construction goals in the policy narrative used by the NWBP was also evident in a Finnish language brochure published by the Ministry of Environment (2020) on its website, freely translated into English as “Climate-wise construction: Why Finland needs to be built with wood?”

The NWBP was classified as a regime-based intermediary. It was mandated by the government to promote the transition of the construction and forest sector (in line with bioeconomy agenda). Yet, it also operated in the interface of the WMC niche and the construction regime. It was engaged in several activities, including sharing of information, facilitating and supporting the operation of wood construction related networks, and policy advocacy.

Another regime-based intermediary, operating at the national and regional level was the Finnish Forest Centre (FFC), associated through guidance with the MAF. The organization was connected rather closely with the forest regime. The regional offices coordinated and implemented several projects related to capacity development, network building and awareness in the field of

<sup>4</sup> Organizationally, FFC can be considered to be semi-governmental, as the board includes representative from the interest groups in the forest sector, including forest owners and industries, as well as ministries (MAF and MEEA).



**Table 4**  
Characteristics of the key WMC intermediaries identified.

B	Context/level of action	Emergency	Goals	Position vis a vis a niche	Neutrality
<i>NWBP</i>	National scale (mostly), mandate by regime (coordinated by ME)	Government funded & established programme (2016-), coordinated by ME	Support the Finnish bioeconomy strategy, diversify the use of wood and add value to wood products, low-carbon construction	Coordination outside of the niche (mostly), implementation partly with niche actors	Non neutral (pro WMC solutions)
<i>FFC</i>	National and regional scale, mandate by regime (connected through strategic guidance most closely to MAF)	Funding for regional projects from diverse sources, various starting times Coordinator funded by the organization (FFC) since 2018	Support the Finnish bioeconomy strategy, add value to wood products	Outside of niche (mostly)	Non neutral (promoting wood as construction material, incl. WMC)
<i>FTC</i>	National scale, mandate by companies in wood construction & interest groups	Companies in wood processing & forestry (more than 10 years)	Value added of the forest sector, more diverse and low carbon construction, resource and economic efficiency of construction	Inside of niche	Non neutral (pro WMC solutions)
<i>FFWWI</i>	National scale, mandate by companies in wood construction & material providers	Companies in wood processing & forestry (since appr. 2015, before that associated with wider construction sector interest organization)	Value added of the forest sector	Inside of niche	Non neutral (pro WMC solutions)
<i>Wood Finland</i>	National & regional scales, mandate by regime (connected to MEEA and ME)	Government established & funded (intermittent for decades, restarted last time in 2018)	Bioeconomy growth, value added of the forest sector	Outside of niche (coordination), but participants of networks from inside and outside	Non neutral (pro WMC)

industrial wood construction, including WMC. The FFC has also had a national coordinator on wood construction since 2018, to coordinate projects and participate in the coordination of the NWBP, among others.

The *Wood Finland* network was re-activated following the launch of the NWBP, after being without funding for a couple of years<sup>5</sup> (I1, I10). A network coordinator was appointed in 2018, located at a regional level *Centre for Economic Development, Transport and the Environment*, an agency operating under MEEA. The network operated as a regime-based intermediary because of its mandate and goals, which were closely connected with the interests of the forest regime. Yet, it also played roles typical to a systemic intermediary (e.g. aligning actors, linking companies with funding options). It connected private and public sector actors (e.g. training and research institutions, industrial parks) at local and regional levels, into a national network. Its activities included organizing regular meetings, often showcasing WMC or other wood industry development related initiatives (pers. obs. 5.6.2019).

The *Federation of the Finnish Wood Working Industries* (FFWWI) was another central intermediary promoting WMC. Due to its goals, emergence and context, it appeared as a niche intermediary. It was close to the forest regime and the wood construction niche. The FFWWI started acting as an advocacy organization for the wood products industries and wood building sector in 2015<sup>6</sup>. The main aim of FFWWI was to create demand for the use of through acceleration of industrial wood construction, in which WMC was a central element. The justifications for WMC used in the narrative were also based on climate benefits “...we try to stress all the time that let's not build with wood because it is wood but because it is good in terms of its carbon footprint” (I2).

Operating partly in co-operation with the FFWWI, the *Finnish Timber Council Ltd*<sup>7</sup> (FTC), was another central intermediary, associated with the niche level (wood construction companies) and the forest regime. Owned jointly by FFWWI and two other interest organizations<sup>8</sup>, it received project funding from diverse sources, including ministries and foundations. The FTC produced and distributed information, guidance and advocacy material (e.g. a magazine, a website, a database on WMC buildings) related to WMC and industrial wood construction more broadly.

Among the less central intermediaries in the field of WMC were those that could be characterized as expert and research organizations. These include the *Green Building Council Finland*, and some experts of *VTT Ltd*. In addition, governmental research organizations, including *Natural Resources Institute Finland*, known as *LUKE* and the *Finnish Environment Institute*, known as *SYKE*, were involved in intermediation. Furthermore, selected units of some universities and other higher education institutions appeared among the less central intermediaries identified, in terms of WMC promotion. They were acting at multiple levels (e.g. projects, networks, regime).

Among the research and expert organizations, some organizations (and units) aimed to advance transition towards low-carbon / carbon neutral construction, or wider societal transition towards carbon neutrality and circularity in the society (c.f. [Antikainen et al., 2017](#); [Lazarevic et al., 2019](#)). This feature, together with the fact that they operated at many levels, and often stressing neutrality, suggests they could be characterized as systemic intermediaries. In addition, there were research and expert organizations that promoted WMC (and broader industrial wood construction) more to support the value added by the forest sector (i.e. market orientation).

The *Green Building Council Finland* (GBC) appeared as a systemic intermediary, mostly connected with the actors of the construction regime. The GBC members included several key businesses in the construction industry, but also a large forest industry actor. GBC was mostly striving for systemic change in construction (moving towards carbon neutrality and circularity). As one of the interviewees representing systemic intermediaries (and experts) stated in their mission (I9) “*In our view, the awareness of low-carbon or carbon neutrality [in construction and built environment] is still...This idea need to be spread more widely, and that way make it more impactful.*” Those that were promoting low-carbon sustainability transition saw wood construction as one potential way to advance their broader goals.

Especially in the case of VTT Ltd and GBC, the ideal of material neutrality was stressed, that is, not standing for any particular material. When asked about the relationship between promoting low-carbon construction and wood construction, a representative of one of these organizations (I9) stated: “*I would like to see it in such a way that these things are addressed separately. I would like to see that all materials compete with their own strengths.*” In addition, intermediary work to support low-carbon transitions was typically just one area of work among many others in the expert and research organizations.

Another expert organization that was less central in the promotion of WMC, but intermediating more on low-carbon and construction was *Sitra* (I9). The government-funded think tank mostly acted as a systemic intermediary in broader sustainability transition (as suggested by [Kivimaa, 2014](#)), and took a more neutral position than for instance the regime-based intermediaries. It appeared that *Sitra* had yet had a minor role in WMC intermediation, too, through its involvement in a R&D project related to industrial wood construction, run by Aalto University (pers. communication with a researcher, 11.12.2019), but this was not confirmed. An expert of *Sitra* was also a board member of one of the regime-based intermediaries in WMC, FFC.

A new network linked to WMC emerged in 2018 when five of the largest cities started to promote wood construction jointly, especially through developing common R&D projects. Prior to it, in 2017, political commitments were made by the mayors of the six largest cities of Finland to increase the use of wood in construction, as part of the efforts towards achieving climate goals ([Climate network of the mayors of the six largest cities, 2017](#); [Vihemäki et al., 2019](#)).

<sup>5</sup> The network had apparently been established sometime in the 1990s and was re-activated during the earlier government period ([Puinfo, 2011](#)), but the funding was then cut.

<sup>6</sup> The organization had operated for some years under the Construction Industry before 2015.

<sup>7</sup> Known as *Puinfo* in Finnish.

<sup>8</sup> The Association of the Finnish timber and builders' merchants and the Central Union of Agricultural Producers and Forest Owners (MTK).

**Table 5**

Roles associated with the various types of intermediaries in the facilitation and speeding up of transition towards WMC and low-carbon construction, and examples of activities commonly undertaken by selected intermediaries.

Systemic intermediaries (GBC, research organizations, HEIs)	Regime-based intermediaries (NWBP, FFC, Wood Finland)	Niche intermediaries (FTC, FWWIF)
<p><i>Articulation of expectations and visions:</i></p> <ul style="list-style-type: none"> <li>● Articulation of needs, expectations, requirements (Research organizations: producing assessments about the carbon footprints of different building technologies; HEIs organizing future-oriented seminars with vision building)</li> <li>● Promotion of sustainability (including carbon neutrality) related aims (GBC, HEIs; organizing events, participating in road shows to promote sustainable, low-carbon construction, including WMC)</li> </ul> <p><i>Building of networks:</i></p> <ul style="list-style-type: none"> <li>● Providing, finding &amp; managing funding (research institutions: Joint funding to R&amp;D projects related to sustainable building, wood construction)</li> <li>● Aligning interests and options (GBC: bringing construction industry, policy actors to discuss and develop low-carbon/circularity solutions)</li> <li>● Creating and managing networks (GBC: managing network of companies, public sector organizations to promote carbon neutrality and circularity in the construction sector; SYKE: running networks related to carbon neutrality and sustainability)</li> </ul> <p><i>Learning processes and exploration:</i></p> <ul style="list-style-type: none"> <li>● Knowledge gathering, processing, generation and combination (HEIs, research organizations: conducting research on low-carbon construction and wood construction, and communicating it to policy makers)</li> <li>● Technology assessment and evaluation (VTT Ltd: assessing Carbon implications of different construction technologies)</li> <li>● Dissemination (HEIs and research organizations: publications, organizing open seminars and events to share results)</li> <li>● Education and training (HEIs: training students on different aspects of wood construction and low carbon construction)</li> </ul> <p><i>Other roles:</i></p> <ul style="list-style-type: none"> <li>● Project design, management, evaluation (HEIs, research institutions, GBC: planning, managing projects related to low carbon construction, circularity, wood construction)</li> </ul>	<p><i>Articulation of expectations and visions:</i></p> <ul style="list-style-type: none"> <li>● Articulation of needs, expectations, requirements (NWBP: e-publication about the role of wood in low-carbon construction)</li> <li>● Promotion of sustainability related aims (NWBP: funding/facilitating testing of low-carbon assessment method in wood buildings; NWBP: participating in road shows to promote sustainable, low-carbon construction, including WMC)</li> </ul> <p><i>Building of networks:</i></p> <ul style="list-style-type: none"> <li>● Providing, finding, managing funding (NWBP: R&amp;D funding to private and public sector)</li> <li>● Creating and managing networks (e.g. Wood Finland: re-creating network of R&amp;D actors in industrial wood construction and processing)</li> <li>● Coordinating networks (Wood Finland network)</li> <li>● Brokering and gatekeeping (NWBP: seeking insights from (selected) industry &amp; R&amp;D actors in program steering)</li> </ul> <p><i>Learning processes and exploration:</i></p> <ul style="list-style-type: none"> <li>● Dissemination (FFC: sharing experiences of projects, best practices in seminars/ webinars)</li> <li>● Prototyping and piloting (NWBP: funding/facilitating low-carbon construction assessment methods)</li> <li>● Creating conditions for learning by doing and using (NWBP: funding R&amp;D in pilot projects)</li> <li>● Education and training (FFC: funding and facilitating training events)</li> </ul>	<p><i>Articulation of expectations and visions:</i></p> <ul style="list-style-type: none"> <li>● Articulation of needs, expectations, requirements (FTC: Creating communication materials for building professionals and general public on requirements, advantages, challenges with WMC)</li> <li>● Promotion of sustainability related aims (FTC: organizing and coordinating road shows to promote sustainable, low-carbon construction, including WMC)</li> </ul> <p><i>Building of networks:</i></p> <ul style="list-style-type: none"> <li>● Creating and managing networks (FWWIF: creating a network to connect companies in WMC business and its value chain)</li> <li>● Finding, managing funding (FTC: finding and managing funding for R&amp;D and dissemination activities related to WMC)</li> <li>● Brokering and gatekeeping (FWWIF: representing industry's interests in policy processes, e.g. linked to low carbon construction)</li> </ul> <p><i>Learning processes and exploration:</i></p> <ul style="list-style-type: none"> <li>● Knowledge gathering, processing, generation and combination (FTC: producing toolkits, best practices)</li> <li>● Dissemination (FTC: organizing nation Wood Day event, FTC &amp; FWWIF: sharing information on WMC among wood industry and construction industry, wider. e.g. through publications, seminars)</li> <li>● Education and training (FTC: training building professionals on design of WMC)</li> <li>● Advise and support (FTC: providing advise on how to design WMC in publications)</li> </ul> <p><i>Other roles:</i></p> <ul style="list-style-type: none"> <li>● Standard creation (FTC: developing standards for wood construction, incl. WMC solutions)</li> <li>● Providing professional services (FTC: conducting consultancies related to WMC for ME)</li> </ul>

Based on personal observations (8.5.2019; 5.6.2019), the cities' wood construction network and especially its coordinator based in the capital city, Helsinki, was engaged in intermediation in the area of WMC. The network coordinator collaborated with the NWBP and the Wood Finland network, e.g. through sharing information, and planning events or initiatives jointly. In addition to R&D projects, the cities' network offered arenas for sharing experiences and information, not only between the cities, but also between a wider group of stakeholders, e.g. industry representatives (pers. obs. 5.6.2019). However, the new network was not mentioned in the interviews as a focal actor promoting WMC or low-carbon construction. This could be partly because of the timing and the small number of the interviews, or because the network mostly operated on a scale smaller than the national one, obviously with modest resources. Rather, many of the interviewees considered some of the larger cities as central actors in accelerating WMC.

#### 4.2. Roles of intermediaries and their means of influencing

The intermediaries identified in our research were characterized as systemic, regime-based and niche intermediaries. The intermediaries' roles are summarized in Table 5, with examples of their activities. The means of policy influencing are addressed separately (Table 6). There was no indication of process or user intermediaries being active in our data.

**Table 6**

Ways of influencing associated with intermediaries of different types of and examples of how selected intermediaries have participated in them.

Systemic intermediaries (GBC, research organizations, HEIs)	Regime-based intermediaries (NWBP, FFC, Wood Finland)	Niche intermediaries (FTC, FWWIF)
<ul style="list-style-type: none"> <li>● Political vision building and tightening of the policy demands (Research organizations: demonstrating the climate implications of increased circularity, and use of wood)</li> <li>● Compiling knowledge to support policy change (VTT: informing the low-carbon construction initiative of ME on the impacts of different policy instruments; HEIs: providing information e.g. on experiences of and attitudes on WMC)</li> <li>● Translating policies into practice (GBC: demonstrating low-carbon and circularity related policy goals to the companies in the construction sector)</li> <li>● Creating and managing expert networks to enhance standard creation (GBC: creation and development of environmental standards; HEIs projects to develop tools/standards on carbon assessment) forest/construction sector)</li> </ul>	<ul style="list-style-type: none"> <li>● Influencing standard setting and legislation (NWBP: influencing the shifts in the building regulations to allow more use of wood)</li> <li>● Creating and managing networks e.g. to lobby for local level policies, to inform government (FFC: creating networks between local actors to lobby for WMC and wood construction in the cities)</li> <li>● Compiling knowledge in support of policy development (Wood Finland: collecting experiences from R&amp;D projects, companies at local and regional level to inform policy processes)</li> <li>● Campaigning, advocating and lobbying (regional, local) (Wood Finland, FFC, NWBP: advocacy targeting municipalities, regional agencies to push for WMC; FFC: advocating industrial wood construction among wood industry, building companies by organizing seminars, events)</li> <li>● Policy implementation (FFC: organizing events jointly with other organizations to inform actors about the regulatory changes linked with WMC)</li> <li>● Policy support (Wood Finland: policy feedback for the government in the network meetings)</li> </ul>	<ul style="list-style-type: none"> <li>● Compiling knowledge in support of policy development (FTC: providing information e.g. on experiences and attitudes on WMC)</li> <li>● Campaigning, advocating and lobbying, e.g. influencing new legislation and policies (FTC &amp; FWWIF: influencing the shifts in the building regulations to allow more use of wood, to support WMC)</li> <li>● Translating policies (esp. building codes) into practice (FTC: providing guidance on the planning of WMC)</li> <li>● Creating and managing expert networks to enhance standard creation, informing the government (FTC: developing standards for WMC building technologies (in the past))</li> <li>● Policy design and implementation (FWWIF: providing feedback on ME on the ways to advance WMC niche)</li> </ul>

All the intermediaries identified had multiple roles. There were also significant overlaps. Several intermediaries were involved in dissemination activities, partly also targeting the same groups. For instance, at the time of interviewing, the NWBP was planning communication campaigns targeting a general audience (consumers) and professionals from the construction industry (including incumbents) (I1), at the same time as niche level intermediaries were planning to target building developers (incumbents) with a communication campaign.

There was also some complementarity among the intermediaries. For instance, one of the regime-based intermediaries, the *Finnish Forest Centre* had several wood construction-related projects at local and regional levels (often in collaboration with cities and R&D organizations), whereas others active in WMC diffusion had a more national focus. The key roles of the regime-based intermediaries were related to learning processes and exploration (e.g. dissemination of information, education and training) as well as building up of the networks (e.g. providing funding for networks and coordinating them).

The network type intermediary, *Wood Finland*, shared some roles with the wood construction network of the cities. However, the latter was not identified as a central intermediary and it also had a different target audience (municipalities, mostly). The aim of *Wood Finland* network was to enhancing mutual learning and coordination of STI activities linked to wood building across a range of “developmental organizations”, e.g. industrial parks and R&D institutions (I13, pers. obs. 8.5.2019). *Wood Finland* had a coordinating role among actors involved in the niche development and diffusion efforts at various levels. It provided an arena for discussing the developments in specific policy processes (such as a roadmap to low-carbon construction) and the implementation of the *National Wood Building Program*, (potentially) helping in both policy design and supporting implementation (pers. obs. 5.6.2019 and 8.5.2019).

From the niche intermediaries, *The Finnish Timber Council Ltd* (FTC) had many roles related to articulation of expectations and visions, network building and learning processes. For instance, it was one of the few actors providing education to building design professionals on WMC and compiling and sharing knowledge on the technical aspects of WMC.

The FFWWI worked in close co-operation with the NWBP and ME both formally and informally. For instance, they provided ideas on the running of the NWBP, e.g. the selection of instruments to advance WMC niche. They had also participated in the discussions or consultations organized by the low-carbon construction initiative of the ME on how to enhance low carbon construction (I2, I7). One of the interviewees associated with these intermediaries described their understanding about the governmental wood construction program, NWBP as follows: “it’s good that we now have some back-up to our efforts at the Ministry, as long as we just get the use of resources and money directed into right spots” (I2). In collaboration with FTC, ME and *Green Building Council* Finland, the organization also took part in translating building code changes into practice, through arranging a road show on public procurement of green buildings in municipalities, through which wood construction was also being promoted (I9).

One of the roles of the FFWWI was to act as a broker between the policymakers (e.g. municipal civil servants), politicians and companies, by facilitating contacts and communication between them. In addition, it played a role in building up the wood construction industry’s internal networks, from the material suppliers to the developers and constructing companies. During 2017–2018, the FFWWI established a working group to promote industrial wood construction, consisting of representatives of wood processing

companies, element manufacturers, and one of the few construction companies active in developing WMC in Finland (I2, I7, I11).

Research and R&D organizations like VTT played an intermediary role by providing research-based knowledge to the regime-based intermediaries, decision-makers at different levels, companies and general public. Some of them also actively collaborated with the companies in STI projects related to tall wooden buildings (I1, I2, I11). Likewise, the higher education institutions (HEIs), including several universities, and universities of applied sciences, mostly acted as knowledge providers, but also in technology assessment, and in creating conditions for learning and doing (e.g. in projects).

#### 4.3. Means of policy influencing

To influence policies, some of the systemic intermediaries engaged in political vision building, such as demonstrating the climate benefits of using wood in multi-storey buildings (Table 6). They were also compiling knowledge to support policy shifts, translating policies into practice and creating networks for standard creation. Some of these activities were also undertaken by other types of intermediaries. For instance, niche intermediaries were active in creating and managing networks for standard creation and in compiling knowledge, in addition to other activities. The means of influencing policies associated with various WMC intermediaries are presented in Table 6.

The fact that the organizational context of the NWBP is the ME, which is also responsible for energy and housing related policies, was considered by some of the interviewees as a focal point for having advanced the WMC niche. It was seen as an important contributing factor in the process to reform the building codes in 2018 to make more space for the use of wood in multi-storey buildings<sup>9</sup> (I2, I13, Paavola, 2019). Some interviewees also perceived that the organizational connection of the NWBP with the ME could positively influence the diffusion of WMC in the future (I4).

Advocating and lobbying activities were mostly undertaken by regime-based and niche intermediaries. For instance, *the Finnish Timber Council Ltd* was reported to have actively participated in lobbying wood construction towards politicians, including the decision by the Sipilä government to launch the wood building programme (I8).

In some cases, individuals associated with research organizations, such as some of the higher educational institutions, had strong informal and formal ties to the other intermediary actors, e.g. due to career history. Therefore, they could bring their knowledge and arguments to the policy processes and programs related to development WMC niche and low-carbon construction (I3). Thus, the influencing by the government associated and other expert organizations was mainly about articulation of the vision and tightening of the demand for policies.

One of the potential ways to advance WMC at ME was the implementation of social housing policies, through the *Housing Finance and Development Centre of Finland*, known also by the acronym ARA. Operating under the guidance of ME, ARA uses financial instruments, such as subsidies for the social housing projects that often target groups with special needs<sup>10</sup>. At the time of the research, ARA was providing funding in few WMC pilot projects, involving R&D elements, and easements for the use of wood when deciding on the subsidized loans (I8, I12). ARA was perceived to have much potential to influence the development of WMC, although it appeared to have had a relatively modest role until recently, by most interviewees who addressed the role of the agency (I1, I8, I10).

However, this positive assessment about the success of the regime-based intermediation (through NWBP), and its potential to further accelerate the diffusion, was not shared by all interviewees. For instance, one of the experts associated with a public sector agency criticized the promotion of wood construction by ME: “*The Ministry [of Environment] should not have become a seller of wood products...It was fitting better when this task was there with the Ministry of Economic Affairs.*” He also suggested that the construction industry at large was strongly questioning the promotion of the wood construction by ME (I12).

## 5. Discussion and conclusions

In this paper, our aim was to make an empirical contribution by expanding research on STTs and intermediaries into a new sub-area of construction and building, related to material sustainability in the case of wooden multi-storey construction (WMC).

Regarding the first research question on which actors and networks operate as intermediaries in WMC on the national scale, we identified intermediaries active in the efforts to accelerate of WMC at the national level in Finland, and explored the types, roles, and means of influencing by the intermediaries identified. In addition, we discovered obstacles and opportunities related to the intermediary field, such as overlaps and complementarities in their roles. An interesting outcome was that many of the key intermediaries had emerged as a result of government efforts and were tied by funding and oversight shared by three ministries. Many of the intermediaries studied were found to have multiple roles, operating at varying levels of intensity.

When classified into the five key intermediary types identified by Kivimaa et al. (2019a), the actors and networks engaged in the efforts to speed up the adoption of WMC were systemic, niche-based and regime-based ones. They either aimed at promotion of low-carbon construction or at reaping more economic and employment benefits from the increased use of wood material in construction. The visions of the intermediaries were partly overlapping and partly differentiated. The systemic intermediaries included many organizations foremost targeting carbon neutrality and higher circularity goals. Yet, this group also included some that were more

<sup>9</sup> The new fire safety regulations of 2018 include several “pro-wood” aspects. For example, it has become possible to use wood as a visible cladding material for interior surfaces, and leave wooden structures partly uncovered with fire-safety panels (e.g. Karjalainen, 2019).

<sup>10</sup> The instruments include interest subsidies and the state guarantee for the loans (ARA, 2015).

focused on the economic goals, e.g. new jobs and greater value added. Among the systemic and niche level intermediaries, the latter orientation was more prevalent.

The system level intermediaries represented the third sector or semi-public organizations (such as GBC, research institutions and higher education institutions). Many of them were involved in the low-carbon transition-related policy making and influencing, e.g. by informing policy processes or translating policies into practice. However, they were not occupying as higher presence in WMC acceleration as the regime-based (and government associated) intermediaries and some niche intermediaries. This can be of relevance for the “success” of the overall intermediation in WMC, as systemic intermediaries are considered focal for transitions to occur (Kant and Kanda, 2019; Kivimaa et al., 2019a). It may mean that some roles typically undertaken by systemic intermediaries may not have been actualized.

Regarding the second research question on how intermediaries of different types participate in the efforts to accelerate market diffusion of WMC, the regime-based intermediaries had multiple, and partly overlapping roles and activities. Many of them were either operating in the form of fixed-term programs, or dependent on funding from these programs, or project funding. The niche intermediaries were more closely associated with the wood industry (e.g. lobby organizations or industry associations) rather than the construction industry. In parallel with the regime-based organizations and networks, they appeared as central players in WMC related policy making and implementation processes.

In general, the intermediaries of different types had many overlaps in their roles and activities. This was evident in network building and management, finding or managing funding, advocacy and lobbying, among others. This is not so surprising, considering that the analytical framework (Table 1) also suggests that there were similar activities and policy advocacy means for different types of intermediaries. However, we also found that specific activities were not fulfilled by any, such as neutral arbitration. It would be beneficial to develop the framework further, based on studies covering a full range of intermediary types, in different contexts.

The third research question addressed the means adopted by intermediaries to influence the policies to advance their goals. Systemic intermediaries were found to have taken part in political vision building, in a similar way as in the framework (c.f. Table 1), but not in policy implementation. They also took part in translating policies into practice, which is not so typical to systemic intermediaries. Furthermore, the ways in which the regime-based and niche intermediaries had sought to influence the policy processes and participated in the implementation were multiple and partly overlapping. For instance, both were active in advocating and lobbying.

Overall, the strength of individual and organizational networks appeared as a significant element of the intermediary field studied. Exchange of information and consultation, both formal and informal, seemed to be a common practice, especially among the actors representing the industry, research and the government. One of the characteristics of the intermediation was that key experts have a work history showing rotations between the intermediary organizations. This has likely contributed to the emergence of collaboration and learning networks between some of the intermediaries. Such a tendency can be partly explained by the small size of the markets and industry, but there are findings on linkages between organizations through shifting experts in other contexts too, based on research by Martiskainen and Kivimaa (2018).

At the same time as there were signs of collaboration and learning networks among some of the intermediaries, the results also indicate that the WMC intermediary field can be characterized as being somewhat fragmented, especially in terms of goals and roles. The degree of coordination between the various organizations involved in the intermediation, especially at the regime level, appeared to be low. This is likely to reduce their capacity to effectively facilitate the development of the WMC niche, even if some of them had similar policy goals. The low degree of coordination observed between the intermediary actors, and their fragmented structures, appeared as weaknesses in the intermediary fields studied when considering the efficiency of their facilitating role in the transition processes. This has also been suggested by Mignon and Kanda (2018) in a different context. Like Kanda et al. (2020) pointed out, intermediaries may lack sufficient direction, willingness, and capacity, which can lead them to complementing, but also competing with each other for resources, mandate and relevance.

Interestingly, two types of transition intermediaries did not appear in our study. There was little indication regarding active presence of user intermediaries (such as those engaging end-users) and process intermediaries (neutral supporters and facilitators of projects or processes), which is also evident from Table 5. Lack of such actors may reduce the overall effectiveness of the intermediary field as user intermediaries are especially considered important for the diffusion of innovations (c.f. Mignon and Kanda, 2018). The potential lack of user intermediaries is perhaps not very surprising. For instance, earlier studies found user considerations to be weak in building procurement processes (Vischer, 2008). The lack of user and process types may also partly be explained by the fact that our focus was at the national level. Moreover, because our study was not initially built on intermediary theorizing means that we may not have been able to identify all possible intermediaries in this field.

Our empirical results contribute to the STT literature (Markad et al., 2016; Köhler et al., 2019) by pointing out some of the challenges involved, with a central role being assigned to the regime-based intermediaries in the acceleration of STTs (especially in the field of WMC), and limited evidence of actively engaging user and process intermediaries. Another challenge was the project-based funding and other resources available for the regime-based intermediaries, many of which took the form of platforms or programs. They were typically dependent on the four-year government terms. The relatively short duration of resources can translate into limited influence of the intermediaries in the longer term.

In comparison with low-energy building in the UK, where intermediary organizations have managed to influence policy to be more aligned with their aspirations (Kivimaa and Martiskainen, 2018), our results are less conclusive about the effects of intermediaries on policy. This is partly to do with the narrower time scope. There were some signs of increasing ‘room’ for WMC intermediaries to engage in policy processes relevant for WMC diffusion. This was exemplified by the fact that the coordination of governmental activities to promote wood construction (NWBP) has been located within the Ministry of Environment since 2016, a

shift from the previous government period (see also Paavola et al., 2019). In addition, at least one of the niche intermediaries was arguably becoming more closely involved in the policy reform processes, by being called to participate in consultative discussions.

Due to the short timeframe, limited data and qualitative approach used in the study, it is impossible to measure in absolute terms the significance of the intermediation in regard to the market diffusion of WMC. As WMC can be considered to have a niche market share in Finland, there is no clear sign that these innovative technologies would have shifted from the pre-development to the early acceleration phase. Against this background, it appears that the intermediaries have not so far been successful in accelerating WMC. For that to take place, institutionalized practices in the construction sector, including the power relationships of the actors, would need to be destabilized (Hurmekoski et al., 2015; Lazarevic et al., 2019).

Earlier research suggests that slow market diffusion of WMC is the result of several factors both within and outside the niche. These include resistance from and lobbying by the incumbent actors (at the regime level), such as interest organizations representing competing construction materials, the existence of multiple building solutions, the lack of standards for some of the WMC products and systems, and the slow progress in the development of the innovation system around WMC (c.f. Lazarevic et al., 2019). Similar challenges in the sustainability transition of the construction sector have been demonstrated in other contexts, by Martek et al. (2019) in Australia and by Gosselin et al. (2017) in Canada.

Regarding future research avenues, assessing temporal aspects for the effectiveness of the intermediaries and their policy influencing deserves more attention, since they could not be captured in this paper. There are also some specific intermediary groups in the construction sector that deserve a closer look than what was possible within this study. First, the dynamics between transition and non-transition intermediaries could be an important area to explore in detail. Second, despite being absent at the national level, user and process intermediaries might turn out to play more active roles at the regional or local level policy processes. These groups would include city planners and architects and other building designers. For example, Fischer and Guy (2009) emphasized the intermediation by architects in the shift towards low-carbon buildings. Lähtinen et al. (2019) highlighted the role of urban planners in promoting WMC in the Finnish context. Both of these groups have a potentially influential role that deserves further analysis.

Finally, a multi-level analysis of the intermediaries accelerating low-carbon construction, and mapping the evolution of the ecology of intermediaries over time (Kivimaa et al., 2019a), would strengthen our understanding on their interactions. This analysis would need to focus on identifying potential complementarities and gaps among the intermediaries to influence the diffusion of new building materials and technologies.

## Funding

The funding for this research was provided by the Metsämiesten Säätiö Foundation, the Ministry of Agriculture and Forestry of Finland and the Central Union of Agricultural Producers and Forest Owners (MTK). The support provided by these funding organizations is much appreciated.

## Acknowledgements

We would like to thank three anonymous reviewers for their comments on the drafts. We are grateful to all the interviewees for their contributions. Thanks are also due to the organizers of and participants in the TRIPOD workshop (10–11 April 2019, at Aalto University, Finland), for the feedback on the draft.

## References

- Antikainen, R., et al., 2017. Renewal of Forest Based Manufacturing Towards a Sustainable Circular Bioeconomy 13 Reports of the Finnish Environment Institute 2017. Accessed 1 August 2018, available at: <http://hdl.handle.net/10138/186080>.
- ARA, 2015. The Housing Finance and Development Centre of Finland. Loans. Available at: [https://www.ara.fi/en-us/Housing\\_finance/Loans](https://www.ara.fi/en-us/Housing_finance/Loans) (Accessed 15.11.2019).
- Climate network of the mayors of the six largest cities, 2017. Kuuden suurimman kaupungin kaupunginjohtajien ilmastoverkosto. Press Release in Finnish on an Initiative to Strengthen Sustainable Urban Growth through Wood Construction (Aloite 13. Puurakentamisella vahvistetaan kaupunkien kestävä kasvua). Available at: <https://www.ouka.fi/documents/173447/260934/ilmastoaloite-puurakentamisen-edistaminen.pdf/885d7e27-c44f-430b-873a-2b9976e914d6> (Accessed 11.2.2020).
- Fischer, J., Guy, S., 2009. Re-interpreting regulations: architects as intermediaries for low-carbon buildings. *Urban Stud.* 46 (12), 2577–2594.
- Franzini, F., Toivonen, R., Toppinen, A., 2018. Why not wood? Benefits and barriers of wood as a multistory construction material: perceptions of municipal civil servants from Finland. *Buildings* 8 (11), 159. <https://doi.org/10.3390/buildings8110159>.
- Fuenschilling, L., Truffer, B., 2014. The structuration of socio-technical regimes – conceptual foundations from institutional theory. *Res. Policy* 43 (4), 772–791.
- Geels, F.W., 2002. Technological transitions as evolutionary configuration processes: a multi-level perspective and a case-study. *Res. Policy* 31 (8/9), 1257–1274.
- Giesekam, J., Barrett, J., Taylor, P., 2016. Construction sector views on low carbon building materials. *Build. Res. Inf.* 44 (4), 423–444. <https://doi.org/10.1080/09613218.2016.1086872>.
- Gosselin, A., Blanchet, P., Lehoux, N., Cimon, Y., 2017. Main motivations and barriers for using wood in multi-story and non-residential construction projects. *BioResources* 12 (1), 546–570.
- Hemström, K., Gustavsson, L., Mahapatra, K., 2017. The sociotechnical regime and Swedish contractor perceptions of structural frames. *Constr. Manag. Econ.* 35, 184–195.
- Herajärvi, H., 2019. Wooden buildings as carbon storages – mitigation or oration? *Wood Mater. Sci. Eng.* 14 (5), 291–297. <https://doi.org/10.1080/17480272.2019.1635205>.
- Hildebrandt, J., Hagermann, N., Thrän, D., 2017. The contribution of wood-based construction materials for leveraging a low carbon building sector in Europe. *Sustain. Cities Soc.* 34, 405–428. <https://doi.org/10.1016/j.scs.2017.06.013>.
- Howells, J., 2006. Intermediation and the role of intermediaries in innovation. *Res. Policy* 35, 715–728.
- Huang, B., Chen, Y., McDowall, Y., Türkeli, S., Bleischwitz, R., Geng, Y., 2019. Embodied GHG emissions of building materials in Shanghai. *J. Clean. Prod.* 210, 777–785. <https://doi.org/10.1016/j.jclepro.2018.11.030>.

- Hurmekoski, E., Jonsson, R., Nord, T., 2015. Context, drivers, and future potential for wood-frame multi-storey construction in Europe. *Technol. Forecast. Soc. Change* 99, 181–196.
- Ibn-Mohammed, T., Greenough, R., Taylor, S., Ozawa-Meida, L., Acquaye, A., 2013. Operational vs. Embodied emissions in buildings—a review of current trends. *Energy Build.* 66, 232–245. <https://doi.org/10.1016/j.enbuild.2013.07.026>.
- Kanda, K., Kivimaa, P., Kuisma, M., Hjelm, O., 2020. Conceptualising the systemic activities of intermediaries in sustainability transitions. *Environ. Innov. Soc. Transit.* <https://doi.org/10.1016/j.eist.2020.01.002>. (in press).
- Kant, M., Kanda, K., 2019. Innovation intermediaries: What does it take to survive over time? *J. Clean. Prod.* 229, 911–930.
- Karjalainen, M., 2019. Research on Framing Solutions and Home Ownership of Wood Apartment Buildings in Finland. *Puu* 2019 (1) 60–64. Available at: [https://www.puuinfo.fi/sites/default/files/Puu\\_1\\_2019\\_lowres\\_0.pdf](https://www.puuinfo.fi/sites/default/files/Puu_1_2019_lowres_0.pdf) (Accessed 29.7.2019).
- Kemp, R., Schot, J., Hoogma, R., 1998. Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. *Technol. Anal. Strateg. Manag.* 10 (2), 175–195.
- Kivimaa, P., 2014. Government-affiliated intermediary organisations as actors in system level transitions. *Res. Policy* 43 (8), 1370–1380.
- Kivimaa, P., Martiskainen, M., 2018. Dynamics of policy change and intermediation: the arduous transition towards low-energy homes in the United Kingdom. *Energy Res. Soc. Change* 44, 83–99.
- Kivimaa, P., Boon, W., Hyysalo, S., Klerkx, L., 2019a. Towards a typology of intermediaries in sustainability transitions: a systematic review and a research agenda. *Res. Policy* 48, 1062–1075.
- Kivimaa, P., Hyysalo, S., Boon, W., Klerkx, L., Martiskainen, M., Schot, J., 2019b. Passing the baton: how intermediaries advance sustainability transitions in different phases. *Environ. Innov. Soc. Transit.* 31, 110–125.
- Köhler, J., Geels, F.W., Kern, F., Markard, J., Wieczorek, A., Alkemade, F., Avelino, F., Bergek, A., Boons, F., Fünfschilling, L., Hess, D., Holtz, G., Hyysalo, S., Jenkins, K., Kivimaa, P., Martiskainen, M., McMeekin, A., Mühlemeier, M.S., Nykvist, B., Onsongo, E., Pel, B., Raven, R., Rohrer, H., Sandén, B., Schot, J., Sovacool, B., Turnheim, B., Welch, D., Wells, P., 2019. An agenda for sustainability transitions research: state of the art and future directions. *Environ. Innov. Soc. Transit.* 1–32. <https://doi.org/10.1016/j.eist.2019.01.004>.
- Korhonen, J., Giurca, A., Brockhaus, M., Toppinen, A., 2018. Actors and politics in Finland's forest-based bioeconomy network. *Sustainability* 10, 3785.
- Lähtinen, K., Malm, N., Toppinen, N., 2019. Effects of lobbying among urban planners in Finland – views on multi-storey wooden building. *Bioprod. Bus.* 4 (7), 77–92.
- Lazarevic, D., Kautto, P., Antikainen, R., 2019. Finland's wood-frame multi-storey construction innovation system: analysing motors of creative destruction. In press. *For. Policy Econ.* <https://doi.org/10.1016/j.forpol.2019.01.006>.
- Lehmann, S., 2013. Low carbon construction systems using prefabricated engineered solid wood panels for urban infill to significantly reduce greenhouse gas emissions. *Sustain. Cities Soc.* 6, 57–67.
- Lucon, O., Urge-Vorsatz, D., Zain Ahmed, A., Akbari, H., Bertoldi, P., Cabeza, L.F., Eyre, N., Gadgil, A., Harvey, L.D.D., Jiang, Y., Liphoto, E., Mirasgedis, S., Murakami, S., Parikh, J., Pyke, C., Vilariño, M.V., 2014. Buildings. In: Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, I., Brunner, S., Eickemeier, P., Kriemann, B., Savolainen, J., Schlömer, S., von Stechow, C., Zwickel, T., Minx, J.C. (Eds.), *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Mahapatra, K., Gustavsson, L., Hemström, K., 2012. Multi-storey wood-frame buildings in Germany, Sweden and the UK. *Constr. Innov. Inf. Process. Manag.* 1, 62–85.
- Markad, J., Suter, M., Ingold, K., 2016. Socio-technical transitions and policy change – advocacy Coalitions in Swiss energy policy. *Environ. Innov. Societal Trans.* 18, 215–237.
- Martek, I., Hosseini, R., Shrestha, A., Edwards, D., Durdyev, S., 2019. Barriers inhibiting the transition to sustainability within the Australian construction industry: an investigation of technical and social interactions. *J. Clean. Prod.* 211, 281–292.
- Matinaro, V., Liu, Y., 2017. Towards increased innovativeness and sustainability through organizational culture: a case study of a Finnish construction business. *J. Clean. Prod.* 142, 3184–3193.
- Mignon, I., Kanda, W., 2018. A typology of intermediary organizations and their impact on sustainability transition policies. *Environ. Innov. Soc. Transit.* 29, 100–113.
- Ministry of Economic Affairs and Employment, 2014. Sustainable Growth from Bioeconomy: the Finnish Bioeconomy Strategy.
- Ministry of Environment, 2020. ND. Ilmastoviisasta rakentamista: Miksi Suomi pitää rakentaa puusta? (Climate-wise construction: Why Finland needs to be built with wood?). Available at: <https://www.ym.fi/download/noname/%7B70A9F586-0FFD-44E3-8947-6B166A3B6E3B%7D/154702> (Accessed 11.2.2020).
- Moss, T., 2009. Intermediaries and the governance of sociotechnical networks in transition. *Environ. Plan.* 41, 1480–1495.
- Paavola, H., 2019. Loppuraportti. Puurakentamisen ohjelman kehittävä arviointi. Witmill Oy & Ympäristöministeriö. Unpublished Evaluation Report on the National Wood Building Programme Ministry of Environment.
- Puuinfo, 2011. PuuSuomi-verkostohanke edistää puurakentamista maakunnissa – uusia yrityksiä tarvitaan (19.9.2011). Available at: <https://www.puuinfo.fi/tiedote/puusuomi-verkostohanke-edist%C3%A4%C3%A4-puurakentamista-maakunnissa-%E2%80%93-uuusia-yrityksi%C3%A4-tarvitaan> (Accessed 30.7.2019).
- Rakennustutkimus, R.T.S.Oy, 2018. Asunto- ja palvelurakentaminen kunnissa 2018 – 2020 (Helsinki: Rakennustutkimus RTS Oy). Available at: <https://www.ym.fi/download/noname/%7BA73C81E3-DA1E-4838-B067-6E55AB89BD23%7D/139890> (Accessed 26.5.2019).
- Roberts, C., Geels, F.G., 2019. Conditions for politically accelerated transitions: Historical institutionalism, the multi-level perspective, and two historical case studies in transport and agriculture. *Technol. Forecast. Soc. Change* 140, 221–240. <https://doi.org/10.1016/j.techfore.2018.11.019>.
- Rohrer, H., 2001. Managing the technological transition to sustainable construction of buildings: a Socio-technical perspective. *Technol. Anal. Strateg. Manag.* 13 (1), 137–150.
- Smith, A., Raven, R., 2012. What is protective space? Reconsidering niches in transitions to sustainability. *Res. Policy* 41 (6), 1025–1036.
- Smith, A., Hargreaves, T., Hielscher, S., Martiskainen, M., Seyfang, G., 2016. Making the most of community energies: three perspectives on grassroots innovation. *Environ. Plan. A* 48 (2), 407–432.
- Toppinen, A., Sauru, M., Pätäri, S., Lähtinen, K., Tuppura, A., 2019. Internal and external factors of competitiveness shaping the future of wooden multistory construction. *Constr. Manag. Econ.* 37 (4), 201–216. <https://doi.org/10.1080/01446193.2018.1513162>.
- Van Lente, H., Hekkert, M., Smits, R., van Waveren, B., 2003. Roles of systemic intermediaries in transition processes. *Int. J. Innov. Manag.* 7, 247–279.
- Vihemäki, H., Ludvig, A., Toivonen, R., Toppinen, A., Weiss, G., 2019. Institutional and policy frameworks shaping the Wooden Multi-Storey Construction markets: a comparative case study on Austria and Finland. *Wood Mater. Sci. Eng.* <https://doi.org/10.1080/17480272.2019.1641741>.
- Vischer, J.C., 2008. Towards a user-centred theory of the built environment. *Build. Res. Inf.* 36 (3), 231–240.
- World G.B.C., 2019. World G.B.C. Available at (Accessed 23.10.2019): [https://www.worldgbc.org/sites/default/files/WorldGBC\\_Bringing\\_Embodied\\_Carbon\\_Upfront.pdf](https://www.worldgbc.org/sites/default/files/WorldGBC_Bringing_Embodied_Carbon_Upfront.pdf).