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THE ROLE OF BOARD INTERLOCKS IN INCREASING THE USE OF WOOD IN CONSTRUCTION

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ABSTRACT: This paper studies the existence of board interlocks between wood-based firms in the construction supply chain and firms in other industries and their role in enabling increased use of wood in construction. Despite recent technological developments in wood-based construction, it is still a niche within the construction market. The literature highlights two main barriers to wood-based construction: (1) lack of material expertise and (2) lack of coordination and collaboration across the supply chain. Interfirm governance structures, such as board interlocks, may constitute a path towards innovation in construction by establishing strategic partnerships. By combining resource dependence theory and dynamic capabilities, we formulate expected findings and analyse these through social network analysis and interviews with board of director's members of wood-based firms in Norway. The dataset consists of 549,449 firms. We find that most wood-based firms have board interlocks with other firms. Furthermore, these other firms are spread across industries, but most belong to industries within the construction supply chain. Additionally, the role of these board interlocks is not to secure access to material resources but to access immaterial resources, such as knowledge, expertise and skill, which contribute to the firms' dynamic capabilities and consequently their competitive advantage.

KEYWORDS: Wood, construction, board interlocks, resource dependence theory, dynamic capabilities

1 INTRODUCTION

This paper studies a specific type of interfirm governance structure, namely board interlocks or directorate interlocks, which occurs when the same person is a member of the board of directors (BoD) in two different firms [1]. More specifically we study if there exists board interlocks between wood-based firms in the construction supply chain and firms in other industries, and their role in enabling increased use of wood in construction.

There is plenty of evidence supporting the substitution effects of replacing the most common building materials with wood-based products [2–4]. New solutions have also developed, such as wood multi-storey constructions [5–7], and the focus on digitalization of the supply chain has increased [8, 9]. Still, wood-based construction is a niche in the European and global construction market [10, 11]. The literature highlights two main barriers to the increasing use of wood in construction: (1) the lack of material expertise [5, 12, 13], and (2) the lack of coordination and collaboration across the construction supply chain [10, 14, 15]. Miozzo and Dewick [16] argue that interfirm governance structures may constitute a path towards innovations in construction by establishing strategic partnerships. One specific type of interfirm governance structure is board interlocks. Previous studies of board interlocks have shown that they secure access to resources of other firms, such as materials, technology and expertise [17–19], and that they enable coordination and collaboration across the supply chain [20, 21].

Moreover, we study board interlocks through the lens of resource dependence theory and the notion of dynamic capabilities. Resource dependence theory allows us to understand why and how organisations, such as wood-based firms, may establish relations to their external environment and, to some extent, the role of such relations. The notion of dynamic capabilities allows us to further elaborate the role of such relations, especially it's role within specific organisations, such as a wood-based firms. These allow us to formulate expectations for an empirical analysis of registry data, using social network analysis (SNA) and analysis of interview data.

2 LITERATURE REVIEW

In this section we review the literature on the use of wood in construction and main barriers to increasing the use of in construction, which forms the basis for our research question. The construction sector has a considerable economic and social importance and is a sector with major environmental impact. If we include the whole lifecycle of buildings, the global construction and building sector stands for 42% of total energy consumption, 35% of total greenhouse gas emissions, 50% of extracted materials and 30% of water consumption [2]. Improving the resource efficiency and sustainability in the building sector has thus become an important climate policy goal in the EU and in the Nordic countries [22–24]. In this context, an increased use of wood is seen as having large potential as a substitute for more energy intensive and non-renewable

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materials [25]. There is plenty of evidence supporting the substitution effects of replacing the most common building materials with wood-based products [2–4]. Studies on the mitigation potential of wood use in buildings and furnishing have shown that wood products have lower greenhouse gas emissions than the alternatives, considering the complete life cycle of the product [26]. It is also superior to common construction materials, such as concrete and steel, when considering all performance indicators [27]. Increasing the use of wood in construction is also important because it enables a transition to the circular economy through recycling [28].

Previous literature about the sustainability transition of the construction sector in general has targeted low-energy houses or passive houses [29], while the literature on the wooden construction industry has been mainly technical and focused on qualities of materials and assembling techniques [25, 30–32] or on specific projects [33, 34]. However, in recent years, a body of literature has developed concerning the role of wood multi-storey constructions (WMCs) in the sustainability transition of the construction sector, as the need for such a transition has become increasingly apparent. Research on new solutions, such as designs using cross laminated timber (CLT) or glulam, has developed [5–7]. In addition, there has been an increased focus on digitalization of the supply chain [8]. Even though wood-based construction is gaining momentum [35], it is still a niche in the European and global construction markets and so there is a potential for expansion beyond the niche [10, 11].

The literature highlights several barriers to the increased use of wood in construction and lack of material expertise among actors in the supply chain (e.g. consultants, architects, construction engineers and contractors) has previously been highlighted as one of the main barriers [36]. Gosselin et al. [12] further confirmed this finding in a review of scientific literature and major construction projects that used wood. More recently, an interview study in Finland concluded that the lack of construction expertise was considered one of the major obstacles [5]. Santana-Sosa and Kovacic [13], in their study based on a literature review and expert interviews, also highlighted the lack of material expertise as a barrier.

However, this is not the only barrier. Mlecnik [37] showed how the project-based approach may hinder innovation within the construction sector, and how enhanced coordinated collaboration may enable better conditions for innovation. Gosselin et al. [38] studied fifteen wooden construction projects in nine different countries, using a mixed methods approach. They showed how the increased use of wood is obstructed by the complexity of the supply chain relationship, and that partnerships along construction supply chains rarely reach outside the project level. A more recent study by Gosselin et al. [15] further supports the need for collaboration and tighter relations along the supply chain. Furthermore, Santana-Sosa and Kovacic [13] recommend that experts on wood construction should be included in the early stages of the design phase to avoid re-design, cost, and time overruns. Gharaibeh et al. [14] present a similar finding when studying the implementation of Building Information Modelling (BIM) in wood construction projects. Finally, the review by Jussila et al. [10] on WMCs market development calls for more research on forms of collaboration within the construction supply chain.

The outlined barriers to the increased use of wood in construction call for further research on this issue. Miozzo and Dewick [16] argue that interfirm governance structures can constitute a path towards innovations in construction, such as applying new materials or products based on new materials, by establishing strategic partnerships. A specific type of interfirm governance structures are board interlocks or directorate interlocks, which occurs when the same person is a member of the board of directors (BoD) of two different firms [1]. Studies have shown that board interlocks secure access to resources from other firms, such as materials, technology, expertise and information [17–19, 39]. Palmer [21] has also shown that multiple board interlocks increase the likelihood of collaboration through joint ventures. Gulati and Westphal [20] also found that board interlocks may be influential in forming strategic alliances, which enables collaboration, depending on the context of the board interlocks. Board interlock may also positively influence firms' innovation performance [40–42].

Drawing on this literature we formulate the following research question: *To what extent do board interlocks exist between wood-based firms and firms in other industries, and what role do they have in enabling increased use of wood in construction?*

3 THEORETICAL FRAMEWORK

The theoretical framework for this paper is draws on resource dependence theory and the notion of dynamic capabilities. Resource dependence theory allows us to understand why and how organisations, such as wood-based firms, may establish relations with their external environment and, to some extent, the role of such relations. The notion of dynamic capabilities allows us to elaborate the role of such relations further, especially their role within a specific organisation.

The premise of resource dependence theory states that the environment surrounding organisations is uncertain, and that the organisations try to gain control over this uncertain environment, and avoid dependence, because they need a persistent and reliable flow of resources [1]. The source of uncertainty is the existence of interdependencies, which describes a situation where "one actor does not entirely control all of the conditions necessary for the achievement of an action or for obtaining the outcome desired from the action" [43, p. 40]. Furthermore, a central assumption of resource dependence theory, which separates it from ecological

and institutional perspectives, is that managers within an organisation have discretion, which entails the ability to actively manage the uncertainties of the external environment [44]. Another important distinction is that resources are not just material, but may also be immaterial resources such as expertise or specific skills [45].

Malatesta and Smith [46] present three main strategies for reducing uncertainty and dependence: (1) Mergers, (2) alliances and (3) co-opting or board interlocking (hereafter board interlocking). The choice of strategy depends on how much control over resources the focal organisation views as necessary [47]. The strategies can be viewed as a part of a continuum because they require varying degrees of coordination and loss of autonomy [46]. Furthermore, the control gained by applying these strategies is highly dependent on the characteristics of the organisation's environment. The literature suggests that board interlocking is the most likely strategy for gaining control in environments characterised by low concentration and high levels of competition [43, 46]. A study by Boyd [48] showed that the number of board interlocks is greater in such environments. The assumption is that through board interlocks, the focal organisation trades sovereignty to an organisation in which the focal organisation is dependent on, which in turn establishes self-interest in the focal organisation's development and survival [49]. The construction sector is characterised as a highly competitive sector with low concentration [50–53]. Therefore, we expect wood-based firms to use board interlocks as a strategy for gaining control and reducing their dependency on the environment.

Expectation 1: A majority of the wood-based firms will have board interlocks with other firms.

Another relevant characteristic of the construction sector is the complexity of the supply chain relationship [15, 37, 38]. A construction supply chain encompasses architects, engineers, builders and suppliers [15, 54]. Papadopoulos et al. [55] describe how the construction supply chain differs from the manufacturing supply chain because of the frequent changes in product, production, and location. Board interlocks may enable better coordination with the environment because it establishes a channel for communication between firms [46, 56, 57]. Given the need for coordination, we expect the wood-based firms to have board interlocks with actors across the construction supply chain.

Expectation 2: The wood-based firms have board interlocks with actors across the construction supply chain.

We rely on both resource dependence theory and the notion of dynamic capabilities to understand the role of board interlocks. Within resource dependence theory, board interlocks are viewed as a way to secure access to material and immaterial resources [46, 56]. Wood-based firms are particularly dependent on access to wood and wood-based materials. This dependency suggests that wood-based firms will be more likely to have board interlocks with firms that may supply the necessary material, due to the potential to secure a persistent and reliable flow of resources [1].

Expectation 3: Wood-based firms use board interlocks to secure access to material resources.

Board interlocks also have the potential to function as transfer channels for immaterial resources such as knowledge, expertise and skills between organisations [43, 45, 58]. However, the role of immaterial resources within an organisation is less clear within resource dependence theory. Teece [59, p. 516] developed the notion of dynamic capabilities, which he defines as: "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments". Furthermore, he suggests that the extent to which a firm has this ability forms the basis of a firm's competitive advantage. More recently, Teece [60] disaggregated dynamic capabilities into three processes: sensing, seizing and reconfiguration. Sensing entails identifying opportunities in the environment which requires market understanding, seizing entails addressing the identified opportunity which often require new knowledge and skills. Finally, reconfiguration entails restructuring assets and organisational structures to environmental changes which demands business and management skills.

Expectation 4: Wood-based firms use board interlocks to secure access to immaterial resources such as knowledge, expertise, and skills.

4 METHODS

This paper builds on two types of data: registry data and interview data. The two types of data are used in combination because while the registry data allows for investigation into if, and to what extent, there exists board interlocks between wood-based firms and firms in other industries, it does not contribute to the understanding of the role of these potential board interlocks.

4.1 REGISTRY DATA

We collected the data for this study in February 2022 from the Central Coordinating Register for Legal Entities (CCR), a registry of all firms in Norway. To collect the data, we used the R software and web scraping. Each firm registered in Norway is given a unique identifier. We used this unique identifier to access and collect information about each firm. The information we collected for each firm was the NACE (Nomenclature of Economic Activity) code, the number of employees and the BoD members, if the firm had a BoD. 549 449 firms were registered with a BoD at the time of data collection.

To collect data on firms in the construction supply chain that use wood-based materials in their products, we gathered information on firms that were members of the primary industry organisations in Norway[2] for the promotion of wood-based products. In addition, we collected information on firms that are partners in initiatives working on solutions that promote the use of wood-based products. Based on the collected information, we had a list of 357 firms. Given that we have information about the NACE-code of each firm, it is possible to argue that it is better to use these to identify groups of wood-based firms. This method is problematic because the basis for the classification of firms is activity rather than material used which may lead to inclusion of many non-wood-based firms. A potential limitation with our approach is the reliance on our knowledge of the industry, we may have inadvertently excluded wood-based firms.

For the analyses we created a two-mode network, using the data collected from CCR and the list of wood-based firms. A two-mode network connects firms through persons. The two-mode network allowed us to create a projection of a one-mode network of firms connected to firms from the two-mode network. To get an overview of how connected wood-based firms are to other firms in the network, we calculated the distance from the wood-based firms to all other firms in the network. By only considering directly connected firms (distance = 1) and their NACE-codes, we get an overview of to what extent wood-based firms are interlocked with firms in other industries. An additional measure used in the analysis is degree centrality. Degree centrality measures the number of links (interlocks) a node (a firm or board member) has to other nodes (a firm or board member) in the network. The basis for this measurement is that nodes with many links have a more prominent position in the network [61].

It should also be noted that one firm may be registered with several NACE-codes, which may question the reliability of our analyses based on NACE-codes. We consistently used the first NACE-codes of each firm, but most firms are only registered with one NACE-code [62]. In the remainder of this paper, we will use the term "industry" when we refer to the NACE sections and the term "industry subdivision" to refer to NACE divisions.

4.2 INTERVIEW DATA

Our interview data was collected in the period from June 2022 until October 2022. Our initial sampling strategy entailed creating a one-mode network of persons connected to persons from our two-mode network. From this one-mode network, we calculated the degree centrality. We then selected potential informants among those BoD members of wood-based firms who were well connected to firms in other industries. Furthermore, we added a requirement, that among the firms, the potential informant who was connected to at least one firm should have a couple of employees, as we wanted to avoid sending requests to board members of very small firms. Subsequently, we collected information about the informant's email address and phone number and sent them requests, by email and phone calls, for an interview. However, it was difficult to get any response, after 40 requests with no response we changed strategy. We changed our strategy to something more similar to the snowballing method. This entailed that we reached out to persons we knew or collaborated with in the industry and asked them to recommend informants. In some instances, they made the first request, and we followed up with a more formal request. We made sure that most of these informants were board members of wood-based firms and that they had connections, through board interlocks, to firms in other relevant industries. This strategy led to interviews with seven informants that were well distributed across industries in the construction supply chain. We also conducted two additional interviews: one interview with someone who was not a board member of a firm on our list of wood-based firms, but several firms involved in real estate development, and one with another informant who was a board member of several firms. This informant also had in depth knowledge about the legal and operational aspects the work of BoD.

The interviews were semi-structured, and we used an interview guide as the starting point for each interview. We also adapted our questions depending on the background of the informant and topics that came up during the interview. In the interview guide, we listed several probes that we used if a topic we were interested in was not raised or discussed by the informants themselves. The interviews were all recorded and transcribed. To analyse the interviews, we developed a codebook and used NVivo to code the interviews. The interviews were coded by one person, which can question the reliability of the coding. However, the interviews were conducted as part of a larger project and two persons jointly conducted all of the interviews and discussed the coding and findings, which increases the reliability.

5 RESULTS

The results from the analysis of the different types of data are presented separately. The results from the quantitative analysis of the registry data are presented first, and second the results of the qualitative analysis of the interview data.

5.1 RESULTS – REGISTRY DATA

The results from the analysis of registry data are primarily related to the first two expectations. These state that a majority of the wood-based firms will have board interlocks with other firms, and that the wood-based firms have board interlocks with actors across the construction supply chain. Our analysis showed that of the 357 firms in our list of wood-based firms 81% (N = 289) were

[2] These are: Treindustrien, Norske Trevarer, Byggevareindustrien and Treforedlingsindustrien.

connected to other firms through board interlocks. The wood-based firms were interlocked to 3,113 other firms. Of these 3,113 firms 84 % (N = 2629) are unique firms.

Our analyses show that the wood-based firms are interlocked with firms in all industries across the construction supply chain. However, there is a great deal of variation regarding the degree of interlocks to each of these industries. A majority of the firms, that the wood-based firms are interlocked with are found within the following industries: real estate (24%), construction (13%), manufacturing (7%), and professional, science and technical activities (7%). Only 3% of the firms that the wood-based firms are interlocked with are within the industry of agriculture, forestry of fishing.

The division into industries can be even more detailed by applying industry subdivisions which is a more fine-grained classification. Table 1 shows the most common industry subdivisions, within the most common industries that the wood-based firms are interlocked with. It is interesting that 73% of the construction firms that the wood-based firms are interlocked with are found within the industry subdivision "construction of buildings". This industry subdivision consists of firms involved in development of building projects and construction of residential and non-residential buildings. This indicates that few of the construction firms, that the wood-based firms are interlocked with, are involved in other types of construction, such as construction of bridges. It is also interesting to note that the most common industry subdivision within professional, science and technical activities is related to head-office activities, business, and management activities, and not architectural and engineering activities. However, the second most common industry subdivision within this industry, is architectural and engineering activities, with 30%.

Table 1: *Most common industry subdivision within each industry.*

Industry	Industry subdivisions	Percentage of firms
L Real estate activities	Real Estate activities	100% (734)
F Construction	Construction of buildings	73% (297)
C Manufacturing	Manufacture of wood and products of wood and cork, except furniture; manufacture of articles or straw and plaiting materials	42% (91)
M Professional, science and technical activities	Activities of head offices; management consultancy activities	46% (100)
A Agriculture, forestry, and fishing	Forestry and logging	55% (47)

The firms that the wood-based firms are interlocked with also seem to have a higher mean number of employees, compared to all firms in the same industries. These firms also have a higher mean score on degree centrality, compared to all firms in the same industries, which indicates that the firms that the wood-based firms are interlocked with may have a more prominent position in each industry.

5.2 RESULTS – INTERVIEW DATA

The results from the analysis of interview data primarily relate to the last two expectations which state that wood-based firms use board interlocks to secure access to material resources and immaterial resources such as knowledge, expertise and skills.

5.2.1 Access to material resources

We interviewed several informants with various connections to other firms in other industries through board interlocks. However, when we asked them about how these interlocks might enable a steady supply of material resources, such as wood or more advanced wood-based products, few seemed to think of or use interlocks to secure access to a steady supply of such resources. One informant (2), who was on the board of a carpenter firm and a firm supplying forest plants for planting after trees have been cut down, alerted us to the large difference between the business each firm was in. The products of the forest plant firm would not become usable lumber for the carpenter firm until several decades have passed. Another informant (5) suggested that firms might use interlocks in this way, but added that, in most cases, firms would select the material most suited for a specific purpose, and that this consideration would be given a substantial weight in the decision on material selection. However, the same informant (5) also suggests that an interlock might give some influence in the interlocked firms future developed. This informant is on the board of a firm that often functions as a contractor in larger construction projects and of a smaller firm that builds private houses and prefabricated elements. The informant (5) explains how the additional element of a costumer relation between the contractor firm and the smaller firm enables the firm to give input on future development.

Furthermore, a board interlock might not be a strong enough connection between firms for it to function as a way to secure access to material resources. One informant (1), who was interlocked with several firms across the supply chain because of ownership through a parent company, describes the interlocks something reassuring, in light of the uncertainty caused by the recent pandemic, in the supply of material resources. At the same time, it is also noted by the informant that they are mindful not to make this a too big advantage.

Even so, our interviews show that this should not be interpreted as the only motivation for parent companies to have interlocks with firms they have ownership shares in. Several informants (1, 6, 7 and 8) noted that ownership shares were one of the main motivations for interlocks. One of the informants (6) explain that this is not because

of the parent companies' interest in securing access to material resources, but because of having made investments and wanting to influence and have information about the development of the firm. This finding lends more support to our expectation about immaterial resources, which we now turn to.

5.2.2 Access to immaterial resources

It seems that board interlocks function as a way to secure access to immaterial resources such as knowledge, expertise, and skills. We asked the informants about why they were appointed to the BoD of the various firms. Several (2, 6 and 8) noted that knowledge and experience from wood-based firms was important. One informant (1) also noted that they were actively seeking potential board members with such knowledge and experience, but that they are hard to come by. Many of the informants (2, 3, 4, 6 and 9) also had previous work experience from firms that worked with wood as a material.

Several informants (1, 2, 3, 4, 5, 7 and 9) stressed knowledge and experience from business management, and the ability to engage and understand how the market develops, as important for their appointment as a board member. One informant (3) described how the informant was recruited to the board of a wood-based firm because the firm was facing economic struggles, and that they were subsequently recruited to other firms when the economic situation was improved. Another informant (4) described the importance of having board members that understand the firm's business model and elements that influence the firm's failure or success.

The importance of experience from business management and market understand seems to be related to how the informants perceive the role of the BoD. Many of the informants (2, 3, 5, 6, 7 and 9) view the role of the board BoD as particularly responsible for the long-term development of the firm. They describe how the BoD should be a partner for the CEO in thinking about the future development of the firm. Moreover, they should try to have a more long-term perspective, than the operative management, focusing on future development opportunities, but at the same time, be a supporting actor for the short-term development. Most of the informants (1, 2, 3, 4, 6, 7 and 8) also said that they had experience form previously being on a firm's BoD.

5.2.3 Disqualification, procedures, and competition

Throughout the interviews, the informants also mentioned some issues related to the role and use of board interlocks. The first issue relates to qualification of the board members in making decisions which may benefit the firm of the board member. Some informants (8 and 9) mentioned that in these situations the board member in question would be disqualified from taking part in the decision. The task of the board member is to act in the best interest of the firm in question. This is also in accordance with the legal regulations [64].

This is seemingly not only a legal issue, but it may also be seen as an unfair advantage by the outside world. One informant (1), who had owned several wood-based wholesale firms previously, mentioned this issue. They described how builders became sceptical towards their business and suspected that the sawmill might sell their materials at a cheaper price to their own wholesale firms. According to the informant, ownership increases the need to conduct business in a transparent manner. Another informant (3), who moved from interest organisations to industry, had to cut ties with the former to avoid suspicions around a dual role.

Another aspect which might make it difficult to use boards in a strategic manner is that there may be election procedures in place for selection of board members, especially in larger firms. One informant (3) suggested that the possibility of appointing a strategically important member to the BoD might be difficult, since the election committee might not think of or be aware of the possibility. Another informant (7) suggested that the committees might resort to selecting the person who is next in line, because it is the most convenient, instead of considering the firm's needs.

The final issue relates to competition among firms. One informant (1) mentioned that they tried to collaborate with other firms, but that it was difficult because of the competition. Moreover, collaboration often lead to conversations about acquisition or mergers. This informant also mentioned that the price is of course an important factor for deciding which material to use. This was also repeated by another informant (5). This suggests that it might be difficult to select materials or products that a firm is interlocked with if the price is not competitive.

6 DISCUSSION

According to resource dependence theory, board interlocks allow the focal firm, in case of interdependencies to other firms in the environment, to trade sovereignty for self-interest in the focal firm's development and survival [43, 49]. In contrast to other methods for reducing interdependencies and thereby uncertainty of the focal firm, such as mergers and alliances, establishing board interlocks involves less coordination and loss of autonomy, it is also viewed as the most likely strategy in environments with low concentration and high levels of competition [43, 46]. In the literature, the construction sector is characterised as a highly competitive sector with low concentration [50–53]. We therefore expected that a majority of the wood-based firms would have board interlocks with firms in other industries. Our results, based on the analysis of registry data, show that of the 357 wood-based firms 81% (N = 289) are interlocked with other firms, which supports our expectations. However, our data does not cover the prevalence of mergers and alliances among wood-based firms. This means that we are not able to conclude that

board interlocking is the most likely strategy for the wood-based firms.

The second expectation relates to another characteristic of the construction sector which is the complex supply chain. A construction supply chain encompasses architects, engineers, builders, and suppliers [15, 54]. The complexity of the supply chain also increases because of the frequent changes in product, production, and location [55]. We expected that this complexity of the supply chain would lead to wood-based firms having board interlocks with actors across the construction supply chain, based on the potential for needed coordination board interlocks provide by establishing communication channels between firms [46, 56, 57]. Our results show that the wood-based firms have board interlocks with industries across the construction supply chain. A majority of the firms that the wood-based firms are interlocked with is found within the following industries: real estate (24%), construction (13%); manufacturing (7%), professional, science, and technical activities (7%). However, only 3% of the firms that the wood-based firms are interlocked are found within industry of agriculture, forestry, and fishing which is an important due to their role as the supplier of wood and wood-based materials. Our results also show that most of the interlocked firms within construction are related to the construction of buildings, while few of the interlocked firms are involved in other construction activities, such as construction of bridges. If we consider the interlocked firms within the industry of "professional, science and technical activities", which is where engineering and architectural firms belong, the most common industry subdivision was the one related to head-office activities, business, and management activities (46%). Moreover, the industry subdivision related to engineering and architectural activities was the second most common (30%). Even so, we find support for the expectation that wood-based firms will have interlocks with actors across the construction supply chain. The firms that the wood-based firms are interlocked with also seem larger, in terms of number of employees, compared to all the firms within each industry. They seem to have a more prominent position in the industry network.

The third expectation stated that wood-based firms use board interlocks to secure access to material resources. Wood-based firms are especially dependent on one type of material. We expected them to be more likely to have board interlocks with firms that may supply the necessary materials, due to board interlocks having the potential to secure a persistent and reliable flow of resources [1]. However, our results show that this does not seem to be the case. This is supported by the fact that the main supplier industry, agriculture, forestry, and fishing, is among the industries which few of the firms that the wood-based firms are interlocked are found within, compared to the industries mentioned above. In the interviews, one informant highlighted the fact that there may be a large difference between the materials and products a firm produces and the materials and products a firm needs, even if there exists a board interlock between the two firms. It also became clear that material selection must be based on a consideration of what the best material is for a specific purpose. This suggests that even if there exists a board interlock between a wood-based firm and a construction firm, wood might not be viewed as the best material for a specific purpose, and so another material is used. One implication of this is that it may be difficult to use board interlocks in this way because it creates an expectation between firms that may be difficult to fulfil. Another important aspect is that board interlocks may be too weak of a connection. Based on the interviews, it seems like stronger connections, such as ownership, is needed to secure access to material resources. However, this should not be interpreted as the only motivation for parent companies to have interlocks with firms they have ownership shares in. The interviews highlighted that an important motivation for board interlocks, in the case of ownership, is to have control over the parent companies' investments, receive information, and have influence over the future development of the firm. Additionally, the informants described how using board interlocks in this way may be difficult because of the issue related to disqualification and things may appear to the outside. As a result, is does not seem like board interlocks function the way we expected. In terms of securing access to material resources, there seems to be too weak of a link. Furthermore, the legal and appearance aspects make it difficult for board interlocks to have this role.

The fourth and final expectation was related to the use of board interlocks as a method for securing access to immaterial resources, such as knowledge and skills. In the literature, it is suggested that board interlocks have the potential to function as transfer channels for immaterial resources [43, 45, 58]. Teece [60] describes how such immaterial resources are important for the dynamic capabilities of a firm which involve sensing, seizing and reconfiguration. Our informants highlighted knowledge and experience for wood-based firms as a reason for becoming a board member, and several of them had work experience from firms that uses wood as a material. Moreover, they stressed the need for experience and knowledge about business management and market understanding, which seem to relate to the role of the board as having a special responsibility for the long-term development and future opportunities for the firm. Thus, our expectation about the use of board interlocks as a method for securing access to immaterial resources seems to be supported. It also seems like they contribute to all aspects of Teece's [60] notion of dynamic capabilities: sensing, through their understanding of the market; seizing, through their knowledge and experience concerning new opportunities; and reconfiguration, through their business and management skills.

7 CONCLUSION

This paper contributes to the understanding of the role of board interlocks in increasing the use of wood in

construction. Trough analyses of registry data we show that board interlocks exist between wood-based firms in the construction supply chain and other firms. Furthermore, the firms that the wood-based firms are interlocked with belong to industries across the construction supply chain. Most importantly, the additional analyses of the interview data allow us to nuance our understanding of the role of such board interlocks. We find no support for our expectation that they function as a way to secure access to material resources. However, they do have an important role in securing access to immaterial resources, such as knowledge, expertise and skills. Knowledge and experience from using wood as a material, business and management skills, and market understanding are all important and contribute to important aspects of Teece's [60] notion of dynamic capabilities, which forms the basis of a firm's competitive advantage.

There are certain limitations to this study. The comprehensive registry data allows for a very broad analysis, but it also limits our ability to study the data in a detailed manner. The selection of wood-based firms in the construction supply chain is probably not complete. There may be wood-based firms that have not been included. However, other methods may have been too broad in terms of inclusion or required an extensive amount of time and resources. Historic data was not available, which does limits us to study data collected at one point in time. This means that we were not able to discuss development over time. Regarding the interview data, more interviews would have been preferrable, but given the difficulties of recruitment, this was not possible in the time available.

Future research should focus on further exploring the role of board interlocks in increasing the use of wood in construction. We specifically suggest case studies of BoD to further the understanding of internal dynamics within firms. Future studies may also consider board interlocks and their relation to alliances and mergers. Finally, we suggest that studying firms who have made or are in a transition towards use of more wood-based materials may be an important avenue for future research.

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