Journal of Cleaner Production 327 (2021) 129474

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Wood material selection in school building procurement – A multi-case analysis in Finnish municipalities

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ARTICLE INFO

Handling Editor: Zhen Leng

Keywords:
Green public procurement
Sustainable construction
Green construction
Wood
Timber
Municipality

ABSTRACT

Municipalities are increasingly adopting green public procurement practices in construction projects; one example is the specification of preferred building materials in public procurement tenders. Before tendering documents, different stakeholders and their ambitions influence the framing of material requirements. In this paper we explore factors initiating wood material selection in five public procurement cases, where the initiation phase of the procurement resulted in wood material use requirements specified in the public procurement tenders. Based on the cases, we constructed potential paths leading to building material requirements to be set in the tender documents. We also identified triggers initiating construction projects and offer a discussion of the role of different determinants related to building material use. These identified paths, triggers, and determinants unveiled the dynamics behind building material requirements in public procurement tenders and more specifically, the actions and underlying values for doing so.

1. Introduction

The transition toward sustainability involves technological changes as well as changes in practices, culture, networks, regulation, and infrastructure (de Oliveira et al., 2013; Morone, 2018). The construction sector has the potential to significantly contribute to the transition, as it is one of the most significant carbon-intensive sectors. Annually, its practitioners are responsible for more than 20% of the carbon dioxide emissions originating from global economic activities (Huang et al., 2018). Additionally, the sector is also one of the main contributors to energy consumption, other greenhouse gas emissions, material extraction, and water consumption (e.g., European Commission, 2011; Bohari et al., 2017; Bohari et al., 2020; D'Amico et al., 2021).

Using low-carbon building materials is one way to reduce carbon dioxide emissions; other methods include extending the lifecycle of existing buildings (Huuhka and Vestergaard, 2019) and promoting the energy efficiency and renewable energy use of machines in new construction (Huang et al., 2018). In discussions of building materials, wooden materials have generally been considered as low-carbon, suggesting that their use would lower the environmental impact of new buildings (Viholainen et al., 2021). Additional benefits include wood's abilities to be a restorative material, balance indoor moisture, prevent bacterial growth, and provide a warm atmosphere (Alapieti et al., 2020). Such benefits are, however, difficult to express in monetary terms and thus easily considered as having no market value (Hurmekoski et al., 2015).

Wood material use may help in achieving climate change mitigation targets and supporting users' well-being. Such benefits do not directly benefit the building procurer by providing cost savings; instead, the benefits are partly indirect and actualized in the long-term. Moreover, despite the perceived benefits, the adoption of new building solutions can be challenging in the construction sector, as it is particularly risk-averse (Arora et al., 2014) and technological changes can take several decades to be realized (Reichstein et al., 2005; Mahapatra and Gustavsson, 2008). Reasons behind this have been referred to as liabilities: the liability of immobility of the product and the liability of unanticipated demand (referring to how demand is uncertain, complex, involves several stakeholders, and depends on fixed capital investments [Reichstein et al., 2005]). Furthermore, path dependency of an established construction system could also deter the diffusion of new practices in the

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https://doi.org/10.1016/j.jclepro.2021.129474
Received 26 May 2021; Received in revised form 13 September 2021; Accepted 22 October 2021
Available online 23 October 2021

sector (Mahapatra and Gustavsson, 2008), with path dependency referring to previous events or decisions affecting the present. New initiatives are needed to step outside these paths to promote sustainable building material use. This research sheds light on such initiatives and forerunner practices for sustainability in the public sector.

In this paper we examine wood material selection in public building procurement, as municipalities are increasingly promoting the use of sustainable building materials. Such initiatives include adopting green practices by, for example, specifying preferred building materials in public procurement tenders. One suggested driver for municipalities' eagerness to promote wood material is linked to their responsibilities for furthering residents' well-being in an economically feasible manner (Jäntti, 2016). However, empirical investigations are lacking with regard to how different stakeholders' levels of commitment, awareness, knowledge sharing, and technical competencies drive greener building projects (Bohari et al., 2020).

Existing research has not adequately covered how wood is introduced in public building procurement projects. Neither it is known what factors facilitate or hinder the selection of wood in public procurement. Thus, we pursued these specific Research Questions (RQs):

RQ1: How is wood material selection initiated in public building procurement processes?
RQ2: What kinds of factors facilitate or hinder the selection of wood material during the procurement process?

In this paper we address these questions by examining recently completed school procurement processes in Finland. The results show how wood material requirements become incorporated into public procurement tenders. To uncover the incorporation mechanisms and value expectations during the procurement process, we first analyzed the procurement processes and then explored discussions as to how and by whom they are connected to wood material selection (cf. Ritala et al., 2021). We used the Switching Path Analysis Technique (SPAT) to identify the *initiating*, *facilitating,* and *hindering* factors for wood selection in public school procurement processes. In the SPAT vocabulary, the initiators are framed as *triggers* and they can be *situational*, *reactional,* or *influential*. The facilitating or hindering factors are framed as *determinants*. After identifying the triggers and determinants in each procurement process, we explain how they are linked to the influence and involvement of different stakeholders. Our analysis offers a detailed account of how wood has become specified in public procurement tenders.

The rest of the paper is structured as follows: The next section explains public procurement and the role of requirement specification in the procurement procedure. We then discuss the benefits and obstacles of using wood as a building material. Next, we present SPAT as our method for understanding the paths leading to wood material requirement specification in school building procurement. We present our findings and discuss them using SPAT vocabulary. We end the paper by offering implications for both literature and practice.

2. Existing analytical lenses

2.1. Procedural view on green public procurement

Municipalities are increasingly promoting sustainability in the construction sector. One example is the specification of green criteria in public tenders (Andrecka, 2017; Kristensen et al., 2021), e.g., by preferring greener building materials (de Oliveira et al., 2013; Bohari et al., 2017; Francart et al., 2019) and emphasizing circularity (Sönnichsen and Clement, 2020). Prior researchers have labeled such procurement practices and decisions as "green public procurement" (Bohari et al., 2017, 2020; Cheng et al., 2018), and the approach has gained a foothold in achieving the transition toward sustainability (Sönnichsen and Clement, 2020). In general terms, green public procurement has been defined as "a process whereby public authorities seek to procure goods, services, and works with a reduced environmental impact throughout their life cycle when compared to goods, services, and works with the same primary function that would otherwise be procured" (European Commission, 2016).

In many parts of the world, municipalities as public entities are subject to strict regulations on procurement when promoting green criteria. In this study, public procurement was acknowledged as being regulated by European Union (EU) directives (European Commission, 2018). At the time of the study, EU regulations allowed eight tendering procedures for public procurement; however, choosing the tendering process is not the only condition for attaining green procurement. Also, the winning tender must be selected, which ultimately decides whether the outcome of the process will be 'green' or not. Indeed, according to European Commission regulations, contracting authorities must choose the best tender following certain award criteria. Alongside selection criteria, award criteria must be set in advance and published in procurement documents. Typically utilized award criteria include the most economically advantageous tender (MEAT), the lowest price approach, and best price-quality ratio approach.

MEAT is a method of assessment where the contracting party can award a contract based on various aspects of the tender submission, other than just price. In a MEAT assessment, various criteria can be weighed in, including quality, price, aesthetic and functional characteristics, technical merit, environmental and characteristics, delivery conditions, among others. In the lowest price or price-only approach, price is the only factor that is considered; the tender with the lowest price wins the contract. Finally, in the best price-quality ratio approach, the selected tender is the one that offers the best value for money, assessed through criteria linked to the subject of the public contract, and may include qualitative, environmental, and social aspects. Typically, the award criteria will be scored using a system that assigns weightings to the different criteria (European Commission, 2018).

Even though formal procedures help structure decision making and interaction in public procurement, the mechanisms within their "real-life" context are more complex. Prior literature on urban development projects shows that decision-making processes proceed via various networks of public and private actors that also interact informally (Klijn, 2008). Less often, processes proceed purely within the context of formal and bureaucratic structures operating at one policy level (Block and Paredis, 2013). Interactions and dialogue require further research, as they are not yet thoroughly understood in the context of sustainable procurement practices (Sönnichsen and Clement, 2020).

The complex, multi-actor, and multilevel nature of the procurement process is also present in our school building procurement cases. School buildings are large investments for municipalities and the impacts of procurement are long-lasting, as the buildings are intended to be used for several decades. Moreover, they are procured rather rarely in one municipality. These characteristics mean that the procurement process and related requirements specifications are crucial, resource-intensive efforts for the municipalities, thus necessitating the involvement of several actors and viewpoints. In this vein, Murtagh et al. (2020) mentioned school buildings as an example of a building product requiring holistic perspectives on sustainability. As procurement objects, they also represent the softer values and societal aspects of sustainability; these have been overshadowed by the "hard" science of sustainable construction, e.g., waste, materials, and energy management (Udomsap and Hallinger, 2020).

2.2. Environmental, financial, and well-being related benefits encourage wood material selection

The use of renewable building materials has gained wider attention in response to increasing pressure to support sustainable urban development. Particularly, the use of wood for construction has gained attention in this trend. Wood use is justified mainly for three reasons:

environmental sustainability, financial benefits, and well-being impacts.

First, wood material use is considered to be a way to reduce the carbon footprint of the building throughout its life cycle (Peñaloza et al., 2016; Hildebrandt et al., 2017). Environmental impact studies show that wood-framed buildings are carbon-neutral (Ritter et al., 2011), have lower environmental impact than steel or concrete structures (Robertson et al., 2012), and can act as carbon stores (Börjesson and Gustavsson, 2000).

These environmental aspects seem to fit well with municipalities' strategic aims in the Finnish context, as almost half the population lives in a municipality that aims to be carbon-neutral by 2030. Increasing the amount of wood in construction projects is seen as an efficient way to reduce carbon footprints and achieve climate targets (Finnish Ministry of the Environment, n.d.). Promoting wood construction is part of Finland's objectives within the strategic theme of carbon neutrality and biodiversity of the current administration. Alongside strategies to promote the use of wood in the construction sector, Finland's support for the cause is reflected in a series of legislative changes where regulations for load-bearing structures and fire safety requirements have been loosened, now allowing wooden constructions of up to eight stories (Puuinfo, 2020). Similar political ambitions to decrease the environmental impact of construction have been reported in other Nordic countries; in Sweden, political support was reported to be a driving force for timber construction (see e.g., Lindgren and Emmitt, 2017).

Second, wood is a useful and versatile building material (Miller et al., 2004, p. 163) and it offers various financial benefits to construction projects (Mahapatra and Gustavsson, 2008; Ritter et al., 2011; Grable, 2018). Production of a wooden building is less complex than concrete buildings, which leads to faster project delivery (Mahapatra and Gustavsson, 2008). In the case of prefabricated wooden building projects, analyses have depicted that costs are the same or less in comparison to concrete constructions (Grable, 2018), and there is potential for more savings through improved logistics and increased prefabrication (Mahapatra and Gustavsson, 2008). Furthermore, aesthetic differentiation from non-wood counterparts allows project owners to capture higher rental rates (Grable, 2018). Finally, the use of wood supports the economic development of forest areas and contributes to national income (Ritter et al., 2011).

Third, wood offers benefits related to well-being. Wood material is considered a restorative material that affects the psychological well-being of occupants (Burnard and Kutnar, 2019; Dematte et al., 2018). By using wood, it is possible to create pleasantness and coziness and improve the atmosphere of indoor spaces or urban environments (Karjalainen, 2002, Dematte et al., 2018; Poirier et al., 2019). Moreover, wood can moderate indoor humidity and has antibacterial properties, which affect the perception of indoor air quality, thermal comfort, and energy efficiency (Virtanen et al., 2000; Rametsteir et al., 2007; Nore et al., 2017; Vainio-Kaila et al., 2017). Some tree species are naturally resistant to decay, which can be exploited in construction (Rametsteir et al., 2007) Such attitudes are partly country-specific, as the use of building materials varies between countries due to traditions and culture, which can be the result of the availability of materials (Høibø et al., 2015).

2.3. What discourages wood material selection in construction?

Despite myriad benefits, there are barriers that discourage the selection of wood for new building construction. First, there are characteristics inherent to the construction sector (see the six *liabilities* identified by Reichstein et al., 2005), in which immobility and unanticipated demand have been identified as deterrents to the diffusion of technologies in the construction sector. For example, shifting to wood as a main building material for multi-story buildings would require changes in products, processes, and organizations (Hurmekoski et al., 2015).

In the Finnish context, industry stakeholders consider wood-related regulations to be excessive and cost-burdensome. For wood multi-story construction (WMC), national building codes regarding fire regulation are perceived as relatively strict, as they require installing automatic sprinklers and encapsulating the structural frame, which can create significant additional costs (Hurmekoski et al., 2018). However, these concerns have been noted by the current administration and steps have been taken toward harmonizing building supervision.

As a result of industrialized concrete construction, the experience and education of construction professionals is centered around bricks and concrete. Therefore, wood can even be considered an old-fashion material (Høibø et al., 2015). Having no experience with wood construction, builders consider they have insufficient knowledge of wood buildings and unclear project management skills for the process (Lindblad, 2019). Furthermore, difficulties related to wood building codes and lack of knowledge related to those codes are important obstacles to the adoption of wood (Gosselin et al., 2016). Thus, the transition toward wood construction requires education and marketing efforts, both of which are costly (Lindblad, 2019). In the Finnish wood-frame markets, suppliers and contractors have created alliances to share risks and costs of development (Hurmekoski et al., 2018).

On the other side, costs also pose an important barrier to the adoption of wood as a structural material, where capital, material, construction, and long-term maintenance costs are mentioned. As identified previously, analyses have shown that costs are the same or less in comparison to concrete construction, when it comes to prefabricated wooden building projects (Grable, 2018). Additionally, there are cost savings through shorter construction times, improved quality control, lighter foundation work, and reduced transportation (Hurmekoski et al., 2015). This might compensate for 25% costlier material, additional fire safety costs, and façade maintenance costs that occur every 10–20 years (Hurmekoski et al., 2015). Furthermore, municipal resources might to be too scarce for environmental consideration (Francart et al., 2019).

Consumers have concerns and prejudices about wood buildings' technical characteristics, perceiving them as more expensive to maintain, less fire-resistant, less durable, and less resistant to decay and insects than other materials (Rametsteir et al., 2007; Lähtinen et al., 2019). There are likewise negative perceptions that forest product companies engage in unsustainable practices (Eastin et al., 2001). Altogether, path dependency (Mahapatra and Gustavsson, 2008; Hemström et al., 2017) and tradition (Høibø et al., 2015) create barriers to the use of wood in construction projects. Path dependency refers to how a decision that is made today is affected by past decisions. The main sources of path dependency are beliefs, perceptions, norms, and rules that guide decisions and activities along certain trajectories (Geels, 2004). Path dependency hampers the willingness of construction professionals to select a material that has a lower degree of standardization than other alternatives, especially one with which they have little expertise (Mahapatra and Gustavsson, 2008).

2.4. Identifying paths behind building materials requirements

We chose the Switching Path Analysis Technique (SPAT [Roos, 2002]) for analyzing the procurement processes, due to its ability to capture the actual events and influencing factors in decision-making. SPAT assumes a procedural view of decision making, as it approaches decision making from a historical perspective.

SPAT is a variation of the widely recognized Critical Incident Technique (CIT, originating from the work of Flanagan, 1954). CIT offers a method for analyzing incidents and describing their criticality, as it involves a set of procedures for collecting direct observations of human behavior affected by broader factors. A critical incident is one in which the objective of an individual's act is widely evident for the observer and consequences are sufficiently evident regarding its effects (Flanagan, 1954). Researchers utilize the technique in content analyses to identify the most frequent quality determinants (Roos, 2002). Compared to other CITs, the SPAT acknowledges the disparities and dynamic nature of

critical incidents (Roos, 1999). It is based on the consequence of a critical incident (Roos, 2002) and provides a broad view of decision-making processes (Selos et al., 2013). In SPAT, an incident has a trigger, an initial stage, a process, and a consequence (Roos, 2002).

Triggers are catalysts that make the decision maker inclined to act; they fuel and steer the process without being visible (Roos, 2002). There are three different types: situational, influential, and reactional. Situational triggers originate from changes within an organization outside of the process (Roos, 2002; Selos et al., 2013). Influential triggers originate from market changes which affect the competitiveness of organizations (Selos et al., 2013). Reactional triggers arise from individuals' (or organizations') immediate responses when they are dissatisfied with a chosen solution.

The decision-making process is illustrated by *determinants* (Roos, 2002); there are three types: pushing, swayer, and pulling determinants. Pushing determinants give the decision maker reasons to act; they *push* toward change. Swayer determinants can accelerate (positive swayer) or delay (negative swayer) the action, but they do not cause the action per se. Finally, pulling determinants bring the decision maker back to the original solution.

Decision-making paths and their triggers and determinants are highly case-specific; what is considered a trigger in one case, could be a determinant in another. The difference between triggers and determinants lies on when they occur in each decision-making process (Roos, 2002). The trigger appears at the beginning of the process and it reveals how the process starts whereas the determinant is part of the decision process itself.

SPAT was first applied to study consumer decision making in insurance, retail, public administration, and retail banking (Roos, 1999, 2002). The technique was later extended to organizational decision-making processes. It was applied in business-to-business supplier switching processes by Selos et al. (2013) when they studied businesses with service elements that had an important role in supplier selection. Furthermore, Saukkonen et al. (2017) demonstrated the applicability of SPAT to explain companies' investment decisions relevant to the adoption of environmental technology.

For this study we utilized SPAT in understanding public procurement processes. As decision-making entities, public organizations vary greatly from consumer-based and private organizations. While private sector organizations seek to maximize wealth for shareholders, public service organizations seek to satisfy the needs of the community (Nutt, 2006) through multiple and sometimes conflicting goals (Rainey, 2003, p. 149), while attaining value for the monies exchanged (Lindholm et al., 2019). These differences are also reflected in public investment decisions, where the overall economic impact of different options is considered given that the most economically advantageous tender must be selected (Lindholm et al., 2019; Walsh et al., 2011, p. 32).

3. Materials and methods

In this paper, we present multiple case studies on school selection procedures. We applied a qualitative research approach suitable for studying complex problems that cannot be explored in isolation from their human and social contexts (Creswell, 2013). Requirement specifications in municipal school building procurement are examples of such a problem. The use of multiple studies enabled us to make comparisons across cases (Fig. 1).

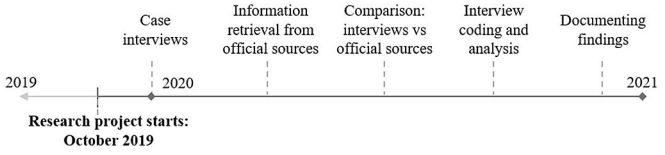

Fig. 1. Research process timeline As shown in Fig. 1, our research consisted of five main stages where multiple data sources were employed.

- First, we conducted semi-structured retrospective interviews (Decker et al., 2020), which served as a primary data source.
- Second, we retrieved information from news outlets, municipalities' websites, and official procurement documents such as contract notices and contract award notices available at EU Tenders Electronic Daily (TED).
- Third, we compared data from interviews to information from official sources to identify if there was any information missing or that required clarification.
- Fourth, we coded and analyzed the interviews using SPAT vocabulary in Atlas.ti, a qualitative data analysis software.
- Finally, we documented our findings.

Through the interviews we were able to capture tacit practices and experiences of the people involved in procurement processes; such knowledge could not be seen from official documents which tend to anonymize the motivations and practices of the actors involved (Decker et al., 2020). Interviewees included professionals responsible for project management, city administration, urban services, and education. As noted by Kumar et al. (1993), multiple informant reports are needed to achieve correspondence between the reports and the studied concepts at the collective level. The informants were identified based on official project documentation and "snowballing." We interviewed 20 people in key roles in each of the five cases. All agreed to follow-up interviews for clarification purposes if needed. Some shared confidential internal documentation related to purchasing decision preparations.

The interviews were analyzed through Atlas.ti. Notes on coding were cross-checked among authors of the paper. The researchers agreed on two main coding families based on SPAT vocabulary: first, triggers (situational, reactional, and influential triggers) initiating the procurement projects, then determinants (pushing, positive swayer, negative swayer and pulling determinants) moving the process toward requiring the use of wood in the tendering phase. Other coding groups emerged as the coding progressed; these include stakeholders (officials and politicians e.g.,"stakeholders_politicians_mayor" or "stakeholders_officials_project engineer") and made decisions (official and unofficial). Weekly discussions within the authorial team (Cresswell, 2000) helped ensure that interpretations of data were not idiosyncratic.

Because our data was collected from a Nordic country that has a history of wood industry, similar findings could be limited to contexts adequately comparable to ours. However, in terms of accumulating scientific knowledge, we can claim that our study provides new knowledge about green procurement practices in general as well. Moreover, our research process itself could well be replicated but the findings in other context might differ from ours, thus contributing to the accumulation of scientific knowledge based on findings in other socio-economic contexts (in other countries and regions) in which ecologic sustainability is sought for through public procurement.

4. Findings

4.1. Overall context of the procurement cases

We selected five public procurement cases from the construction sector; each concerned school buildings that listed wood as the preferred building material. Cases were first selected based on their recent history, which ensured the availability of key informants and their ability to recall critical points in the process as well as justifications of procurement requirements. All cases were based in Finland, meaning that all the municipalities operated under the same national context following EU regulations on public procurement procedures (Public Procurement Directive, 2014/24/EU). They were all from the same region, having forerunner status in promoting wood construction. The region has the second-largest wood construction share from new building construction

in the country. Finally, the cases were representative of the variety of school procurement processes, as they differed in terms of chosen procurement procedure, how wood use was specified in the award criteria, and the actual wood use in the winning tender (Table 1).

4.2. Wood material selection within the school procurement processes

School buildings are rather large and rare investments for a municipality. The investments have direct impacts on the municipality's financials. For return, the municipality may aim for achieving several positive impacts, such as promoting well-being and achieving operational efficiency of different user groups. Naturally, the groups have different requirements for the school building, with material requirements being one. Municipalities may differ in terms of how they engage user groups or other stakeholders in the procurement process. Therefore, procurement processes may differ in terms of how the wishes of school staff, students, and evening users are considered. Due to its rareness, municipal officers may also hire external experts and consultants for taking the process forward. On a general level, the process may engage different municipal officers, vendors, consultants, and user groups in different stages of the process.

In the studied cases, wood material was incorporated to the building material requirements before tendering, selecting the supplier, and contracting (Fig. 2). This indicates that wood becomes considered through other paths than those suggested by bidding vendors. To better understand these mechanisms, we identified the elements initiating the wood material selection in each case.

As shown in Fig. 2, the incorporation of wood into selection criteria does not appear in the same manner across cases. Furthermore, the way criteria related to wood material selection are incorporated in the tendering phase varies; for example, for school 1, tendering documents called for a "mainly wooden" structure, whereas in school 2, requirements specified that "most of the facades, partitions and claddings should be made of wood". Other cases did not have specifications for wood incorporation in tendering criteria but did call for the inclusion of bio-based materials and solutions (school 4) or had award criteria such as "environmental sustainability" and "energy efficiency", which could have supported the incorporation of wood into the project.

4.3. Situational, reactional, and influential triggers

In each procurement case, all three triggers were present. All cases featured major situational triggers, which depict the constantly evolving and multi-actor network environment, typical of the public sector. Drivers for situational changes can be divided into four categories: financial, environmental, strategic and political, and construction related.

- Financial issues established a permissive or restrictive limit on the municipality's budget for the construction project.
- Environmental issues such as carbon-neutrality and sustainable development goals made the municipalities more inclined toward environmentally conscious decisions.
- Strategic and political issues triggered the consideration of wood materials in various ways, either through top-down decisions that mandated their incorporation; through municipality-wide strategies to have more buildings made from wood; or through the desire to increase the municipality's attractiveness, as illustrated by an urban services director's quote, *"Some municipalities that have these wood schools, they use as, it's sort of a way to attract new citizens or inhabitants to the municipality for instance"* (23.09.2020).
- Construction issues encapsulated technical elements that affected the incorporation of wood such as land plot size and shape, the number of stories in the building, and requirements for space versatility.

Reactional triggers were also clearly present in the cases. In most, the consideration of wood materials started as a response to indoor air quality problems in buildings made from "traditional," hard materials such as concrete, as brought up by a construction manager: *"There were indoor air problems, or people suffering from indoor air problems. So that, of course, kicked this issue [school procurement process] forward"* (09.11.2020). The related health problems created a feeling of urgency to react, as described by a technical director: "*There have been such serious health problems and threats that they [schools] have had to be closed down and procured with great urgency*" (29.11.2019).

Influential triggers were mostly present through peer learning, self-learning, cross-municipality competition, and the quest for a positive reputation. Peer learning was identified by a municipality's willingness to learn from another municipality's successful wooden school project as well as their willingness to learn from their drawbacks in the process. Self-learning was present in municipalities that had previously carried out a wooden building project, which gave enough experience and confidence for a larger endeavor, as stated by a structural expert: *"When [new project] was decided it [previous project] was already a good experience"* (15.11.2019).

In this case, influential triggers affect the competitive situation of municipalities. In this study, a desire to stand out from other municipalities and be more competitive in terms of citizen attraction was identified as a driver toward incorporating wood, as directly highlighted by a project manager: *"So if in X [other municipality] is something happening [our] people think we have to be a little bit better and we have to have at least one more wood-framed school"* (28.08.2020). Finally, the

Table 1
An overview of the school procurement cases.

	School 1	School 2	School 3	School 4	School 5
Municipality size*	Large Suburban	Medium Town	Small Rural	Small Rural	Small Rural
Municipality has a wood construction strategy?	Yes	Yes	Yes	No	No
Type of procurement procedure	Open procedure	Open procedure	Competitive dialogue	Competitive dialogue	Competitive dialogue
Amount of wood use specified in the procurement criteria	Yes	Yes	No	No	No
Operative model of the building	Building contract	Turn-key contract	Building contract	Public-private partnership	Turn-key contract
Wood use in the chosen building	Mainly cross-laminated timber (CLT), wood façade	Concrete structure, wood façade	Concrete structure, log façade	Concrete structure and wooden elements	Mainly wooden logs
Number of floors	2	3	2	2	2
Award criteria	Lowest price	MEAT	MEAT	Price-quality	Price-quality
Total value of the procurement	10.0 Me	12.6 Me	16.7 Me	15.4 Me	6.5 Me
In use	2022	2021	2021	2019	2017

*Municipality sizes: Small <10,000 inhabitants; Medium = 10,000 to 100,000; Large >100,000.
Me = Million Euros.

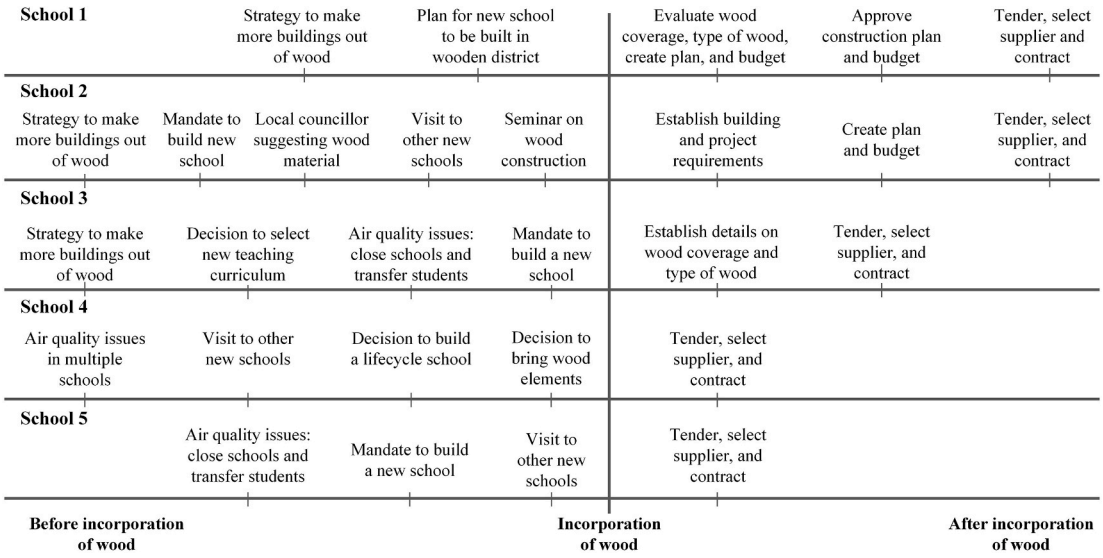

Fig. 2. School procurement process timelines and timing of wood material selection.

quest for a good reputation came primarily from positive media coverage that other municipalities were receiving with regard to their wooden schools; this was captured by a construction manager who said, *"The big school [name omitted] that was being made […] got quite a lot of publicity at the time. So, we also decided that it could be like this"* (09.11.2020). Table 2 summarizes the situational, reactional, and influential triggers initiating wood selection in each case.

4.4. Determinants driving and hindering wood selection in the school procurement process

Determinants brought up by these cases (Table 3) helped us assess which factors move the process toward incorporating wood material requirements into procurement tenders and which factors curtail this progress. In all cases, pushing and swayer determinants were present, where pushing determinants and positive swayer determinants are considered drivers for the wood selection process and negative swayer determinants were identified as hinderances in the process. Pulling determinants were not detected, thus were excluded from Table 3. As with situational changes, pushing and swayer determinants can be pooled into four categories: financial, environmental, strategic and political, and construction related. Interestingly, there were no monetary issues considered as pushing determinants; neither were there any environmental issues as part of negative swayers.

As for pushing determinants, environmental issues included identifying wood as the renewable option thanks to the wooden building's carbon sequestration capabilities, bringing up A-class energy efficiency and future recycling opportunities. The idea that wood construction strengthens local business was identified as a strategic and political issue. Construction issues covered technical elements such as building flexibility, good acoustics, and the possibility of prefabricating buildings, as well as more subjective elements such as a good look, feel, and smell in wood buildings, as brought up by an education manager: *"That warmth and, coziness […] creates such an atmosphere which must be very suitable for such good schooling"* (15.09.2020).

Swayer determinants were mostly negative, meaning that those factors may have slowed down the incorporation of wood in the construction project, but were not concerning enough to halt the process. Financial issues were strongly present across all cases, where the main concern was the higher price of wood in relation to other building materials. Construction issues revealed wooden buildings' poor sound insulation, fire safety concerns, and more pressingly, the perceived lack of experience with and capabilities for working with wood. This was evident from the point of creating the project budget to carrying out the project, as expressed by a project manager: *"What is making it, let's say impossible or difficult to construct buildings in timber is that we don't have that much construction companies or developers who really have, enough competence or knowledge about it"* (28.08.2020). Consequently, small municipalities are not ready to be pioneers in a field where they have little knowledge or experience; this was captured by a construction manager who said, *"Not so much was known about log construction; there is not that knowledge in Finland anyway. And one always doubts whether such a small municipality should become a test project"* (09.11.2020).

4.5. The role of individual actors initiating wood selection

Typical for the building procurement process, all the procurement phases were usually made in interactive groups or committees comprised of politicians, representatives from city council, experts from the technical board, and representatives from the education sector.

Interviewees referred to both strategic-level influence and stakeholder influence when reflecting on the reasons behind selecting wood in the procurement process. As identified in Fig. 2, one of the first events in the process is the decision to build a new school. However, close data analysis shows that between the decision to build a new school and the incorporation of wood, there are typically both political strategy- and influential stakeholder-related elements steering the process toward the selection of wood. This inclination to follow a political strategy can be seen as top-down initiative in Schools 3, 4, and 5, while the influence of active stakeholders was more present in Schools 1 and 2.

As an example of the influence of political strategy, the deciding committee of School 3 was inclined to incorporate wood, as it would cater to the municipal strategy of having more buildings made from the material. This was highlighted by a city manager who said, *"We [politicians] have spoken a lot for wooden materials and use of wood in construction, […] So I believe that that's also been motive when, they did the decision"* (02.09.2020).

As an example of stakeholder influence, a few active municipal civil servants suggested the incorporation of wood into procurement requirements for School 2, as brought up by a local councilor who mentioned *"Hey, we can build it from wood"* (26.08.2020) during a project evaluation seminar. And, even though the suggestion was initially received with skepticism, as highlighted by the interviewee, *"And well, then there wasn't much enthusiasm for it, and I heard a little bit of a laugh about the suggestion,"* it became an item to consider and eventually gained enough support to become a collectively agreed-upon goal.

Table 2
Situational, reactional, and influential triggers initiating wood selection.

School	Situational triggers	Reactional triggers	Influential triggers
School 1: Large Suburban	**Monetary issues:** - Extensive budget available **Environmental issues:** - Bioeconomy and eco-efficiency became a priority for the city - New carbon-neutrality goals2030-2035 - Future constructions will require carbon assessment **Strategic/political issues:** - New city-wide target to have multi-story buildings made from timber - New land plots reserved for wood construction - New legislation affecting building materials	- Recent problems with indoor air quality in concrete buildings	- Good image that other wooden schools received - Competing with neighboring municipalities to attract citizens - Release of official statistics on wood construction positioning the city above others - Webinars on carbon neutrality strategies - Internal learning from recent wooden construction projects
School 2: Medium Town	**Environmental issues:** - New sustainable development goals **Strategic/political issues:** - Recent municipal target to have more buildings made from wood - Municipality's population growth **Construction issues:** - Availability of long land plot; allowed building horizontally - Trend of learning-space versatility - Changing legislation regarding wood building limitations	- Problems with indoor air quality in previous schools	- Visiting and learning from other wooden schools - Finnish Sawmill Entrepreneurs' petition to include wood as an option in public construction projects
School 3: Small Rural	**Strategic/political issues:** - New municipal strategy target to build as much as possible with wood - Curriculum reform warranting co-teaching and flexible learning spaces	- Problems with indoor air quality in old building; school shut down and students transferred - Recent moisture issues with concrete structures	- Internal learning from recent wooden construction projects - Visiting and learning from other wooden schools
School 4: Small Rural	**Monetary issues:** - Limited budget available **Strategic/political issues:** - Curriculum reform warranting co-teaching and flexible learning spaces **Construction issues:** - Large-sized school decision - Trend for increased liability for the tendered over the building lifecycle (lifecycle model)	- Recent problems with indoor air quality in old buildings	- Visiting and learning from other wooden schools that implemented competitive negotiation procedures
School 5: Small Rural	**Strategic/political issues:** - Recent decision to build a unified school with special education **Construction issues:** - Municipality did not want insulation in new construction - The deteriorating condition of the old building - Trend to build with wood - Recent discussion of wood as the solution for indoor air issues	- Problems with indoor air quality in previous school; students partially evacuated and temporarily transferred	- Good image that other wooden schools received - Visiting and learning from other wooden schools

This illustrates how a single suggestion from an influential member of a council group might spark a discussion regarding the incorporation of wood.

A closer look at single influential individuals illustrates that they may have a special preference for and connection to the promotion of wood. For example, the interviewee who said *"Hey, we can build it from wood"* was raised in a family whose members worked in the construction sector and referred to wood as *"an element that has always felt so pleasant and it has somehow had a very positive connotation."* This finding is in line with that of Francart et al. (2019) who suggested that single municipal politicians can remarkably contribute to wood construction, due to their personal motivation and engagement. Altogether, these findings suggest that actively engaged individuals need to be present in the process in order to operationalize the municipalities' strategic goals to promote wood construction.

5. Discussion

5.1. Wood material selection in public building procurement processes

This article contributes to the green public procurement literature with identification and analysis of actual procurement processes in which green criteria have been used (Andrecka, 2017; Kristensen et al.,

Table 3
Synthesis of the determinants in each school procurement case.[a].

School	Drivers (pushing determinants)	Hindrances (swayer determinants)
School 1: Large Suburban	**Environmental issues:** - CO_2 sequestration in wood buildings - Fewer CO_2 emissions - Easy recycling of wooden buildings **Strategic/political issues:** - Positive image **Construction issues:** - Possibility of prefabricating buildings - CLT as a flexible solution - No moisture or humidity problems - Good working environment; nice look, feel, and smell - High fire safety: mandatory sprinklers for multistory buildings - Good acoustics	**Financial issues:** - More expensive than concrete (negative) **Construction issues:** - Small land plot; need to build upward (negative) - Lack of experience with and knowledge about wood construction (negative) - Stricter fire protection measures (negative) - Poor sound insulation (negative) - Thicker midsole required (negative)
School 2: Medium Town	**Environmental issues:** - CO_2 sequestration in wood buildings - A-class energy efficiency - Renewable option **Strategic/political issues:** - Positive image - Image/idea that wood is healthier than concrete - Positive press coverage - Domestic material **Construction issues:** - Good indoor air in wooden buildings - Creates a "good atmosphere" for learning - Good acoustics	**Financial issues:** - Estimated to be more expensive than concrete (negative) - Three-story building; too expensive to be fully wooden (negative) **Strategic/political issues:** - Initial backlash from fire potential and mold accumulation (negative) - Inaccurate information about wooden construction during initial stages (negative) **Construction issues:** - Higher maintenance requirements (negative) - Lack of experience with and knowledge about wood construction (negative) - Poor sound insulation (negative) - Higher heat consumption (negative)
School 3: Small Rural	**Environmental issues:** - Good environmental choice **Strategic/political issues:** - Good reputation and image - Strengthens local business **Construction issues:** - Healthy living option	**Financial issues:** - More expensive than other materials (negative) **Strategic/political issues:** - Small local fire department (negative) **Construction issues:** - Durability of wood not acknowledged by everyone (negative) - Big building with two floors; wooden frame doesn't support it (negative) - Lack of experience with and knowledge about wood construction (negative)
School 4: Small Rural	**Strategic/political issues:** - Wooden constructions are safe and healthy - Good market value	**Financial issues:** - More expensive than concrete (negative) **Construction issues:**
	Construction issues: - Good look and feel	- Bidders experienced with concrete (negative) - No experience building with logs in big projects (negative) - Bidders seek to remove risk and uncertainty in a lifecycle project (negative) - Fire safety issues (negative) - Concrete offers better temperature control (negative) - Adhesive used for wood buildings can bring challenges in the long run (negative)
School 5: Small Rural	**Strategic/political issues:** - Good reputation from log buildings **Construction issues:** - Perceived as a solution for indoor air problems	**Construction issues:** - Fire safety issues (negative) - Lack of experience and knowledge with wood construction (negative)

[a] Pulling determinants were not detected, i.e., determinants that would have cancelled a decision already made to use wood as a building material, and then opt for another construction material.

2021). By studying five school procurement cases and using SPAT, we identified procurement process timelines, triggers, and determinants that together unveiled the dynamics behind building material requirements in these cases. Regarding RQ1, as a key contribution, *our findings provide a rich account of the factors initiating, facilitating, and hindering greener material selection during a procurement process* (building on e.g., de Oliveira et al., 2013; Bohari et al., 2017; and Francart et al., 2019). Particularly, our analysis revealed that:

- Wood selection was often initiated by a situational change (financial, environmental, strategic, or construction related) that paved the way for incorporating material requirements into the selection criteria.
- Indoor air quality issues in a former school building created the urgent need for a new building. This situation represented an opportunity for the municipalities to promote wood material use.
- Analyses of the actors involved in the procurement process revealed that wood use is not only the result of an accumulation of triggers, but also influenced by individual stakeholders. Stakeholder influence bridged the decisions of building a new school and incorporating wood materials into the selection criteria, thus revealing that actively engaged individuals play an important role in operationalizing municipal strategies.
- Moreover, a municipality's tradition of working with the wood industry appeared to influence the incorporation of wood in the selection criteria. Municipalities that had a long-standing tradition with wood or a local wood industry had also set strategy-level goals for increasing the amount of wooden construction. This finding appears to be in line with that of Høibø et al. (2015) in which tradition, culture, and the availability of materials were identified as influencing building material preferences.

5.2. Elements facilitating and hindering wood material selection

Identified triggers were categorized into situational, reactional, and influential. Previous researchers (Gosselin et al., 2016; Franzini et al., 2018; Toppinen et al., 2018) have found similar factors affecting wood material selection, framing them as motivators, contributors, or drivers. However, this study is among the first to unveil the dynamics of these issues in the actual procurement processes over time.

Regarding RQ2, uniquely, we identified the reactional triggers for

wood construction in response to the issues with indoor air quality in concrete buildings. This finding complements those of earlier studies, in which wooden interiors were identified as helping mitigate indoor moisture, preventing bacterial growth (Muilu-Mäkelä et al., 2014), and inhibiting moisture degradation through improved air circulation (Franzini et al., 2018). Furthermore, the finding is in line with that of Hurmekoski et al. (2018), who reported that the "quality of construction and indoor air quality issues" possibly affected the construction market.

Essentially, by unveiling the dynamics of the procurement process, this study offers a depiction of the presence of path dependency (Mahapatra and Gustavsson, 2008; Hemström et al., 2017) as a barrier in the use of wood materials in construction projects. In each of our five cases, construction professionals were less willing to select a building material with which they had little experience and capabilities due to past beliefs, perceptions, norms, and rules.

Interviews related to these cases engaged a variety of municipal civil servants who provided us with an in-depth understanding of their procurement processes. Therefore, our work supports and deepens the work of Franzini et al. (2018) and Toppinen et al. (2018) regarding WMC. Particularly, the identified pushing determinants in the Finnish context have similarities with the supporting attitudes identified by Franzini et al. (2018) and Lähtinen et al. (2019) and internal and external factors found by Toppinen et al. (2018). However, instead of focusing on intentions and attitudes (Franzini et al., 2018) or Delphi techniques (Toppinen et al., 2018) regarding wooden buildings in general, our study reveals the actual procurement processes leading to building procurement and wood material selection.

Lastly, our study broadens the use of the SPAT method from consumer and business decision-making contexts to those relating to public procurement. For this methodological contribution, we briefly commented on the applicability of SPAT in public procurement context. Altogether, SPAT showed its ability to provide useful, in-depth understanding in the studied context. However, the idea of pulling determinants seemed to not be applicable in the context of school procurement. School procurement is an example of a large and irreversible investment. Therefore, the idea of pulling determinants cannot be applied in a straightforward manner. It is natural, then, that such elements were not detected in the interviews.

5.3. Conclusions and recommendations

We explored the paths, triggers, and determinants of public wood construction procurement, and thus unveiled the dynamics behind building material requirements in public procurement tenders. In general, we have shown how utilizing detailed interviews (Cheng et al., 2018) helps better cover the details of green public procurement processes. These findings have implications for both research and practice. The findings on wooden school procurement hold implications to the key areas of green public procurement and sustainable construction research. They also provide understanding of the dynamics related to introducing new practices in public building procurement. In practice, the findings may be especially valuable for municipalities that specify wood use in public procurement for the first time.

The identified triggers and determinants in the public procurement cases also hold practical relevance. As illustrated by our cases, municipal civil servants are increasingly interested in incorporating sustainability related aims to their selection criteria. Specifying wood use in the criteria carries the message that several benefits other than the lowest price are being sought, as illustrated by the list of pushing determinants.

These findings also introduce avenues for future research. The transferability of the results to other sustainable public procurement contexts should be tested. In general, future researchers may require longitudinal, multi-actor perspectives. In particular, the findings from our study suggest that green public procurement and green building material selection result from a multi-stakeholder negotiation of objectives and values. Thus, our research encourages further research on wood construction from a narrative viewpoint, as "narratives of wood use." Such future studies could focus on different user group perspectives or on public discussion, as media also creates and sustains wood construction-related narratives. Furthermore, future studies could evaluate role of wood as a form of preventive innovation in procurement, where wood is utilized to prevent unwanted future health consequences or unwanted environmental consequences associated with traditional building materials.

We have several stakeholders that will benefit from our research. First, based on our findings, policymakers could make sure that there is enough reference information available about wooden buildings. This would support municipalities avoid the feeling that they have to do pioneering work, in the case they wish to avoid risks. For example, a public archive of public wood buildings with details such as costs and benefits could make wood construction more "business as usual" for municipalities. Second, for municipalities to aspire their 'green' goals, our findings provide encouragement to include wood-related criteria to calls for tenders. In the case a call for tender favours a different construction material (such as concrete), it is unlikely that wood is selected – and vice versa. This issue might seem self-evident, but it is not, in practice. Rather, it is not automatic that all officials have the skills to write calls for tenders that favour wood. If this is the case, we recommend using procurement consultants to support 'green' tender writing. Third, and finally, our findings encourage tenderers to argument that wood does not equal more costly. In the long term, with indirect benefits, wood might become less expensive, e.g., if residents do not become ill due to poor indoor air quality, thus saving costs in healthcare for the municipality. Moreover, the life cycle costs of wooden buildings are competitive. While the idea of indirect benefits is not new (e.g., Lindholm et al., 2019), we see that it applies to the wood construction sector as well.

CRediT authorship contribution statement

Deborah Kuperstein Blasco: Formal analysis, Visualization, Writing – original draft. **Natalia Saukkonen:** Funding acquisition, Conceptualization, Writing – original draft. **Tuomas Korhonen:** Project administration, Investigation, Writing – original draft. **Teemu Laine:** Writing – review & editing, Supervision. **Riina Muilu-Mäkelä:** Project administration, Validation, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This study was conducted as part of the Wood for Good research project. We are grateful for the Ministry of the Environment of Finland, Natural Resources Institute Finland (Luke), and Tampere University for funding the project. We would also wish to express our gratitude to the anonymous Reviewers whose help greatly improved the paper along the way, and Prof. Saku Mäkinen for commenting on an earlier version of the article.

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