Incumbent Actions in Adopting Preventive Innovations: Cases in the Finnish Construction Sector

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Abstract - **Wood construction differs from traditional concrete materials in technical and organizational requirements for which it can be studied as an innovation, and thanks to health and climate change mitigation and prevention capabilities, wood construction can be categorized as a preventive innovation. The purpose of this study is to explore incumbent actions in the adoption of wood materials. The context of this paper is an interview study that analyzes public procurement of school buildings that illustrate the role of incumbent actions in the adoption of wood materials. We study the actions of incumbent organizations and identify how these actions relate to the preventive innovation's elements of probability, severity, and time-lapse to see benefits. Findings indicate that the probability and severity of an unwanted event make incumbents more likely to select wood materials and future-oriented benefits are not a deterrent for adoption but instead, are often utilized to argue potentially larger investments. This study provides an overview of prevention-related benefits derived from building materials and highlights what construction sector incumbents ponder when adopting innovations.**

Keywords – **preventive innovation, wood construction, incumbent**

I. INTRODUCTION

Achieving carbon neutrality goals requires changes in products, processes, and organizations, particularly within specific sectors. The construction sector is one of the most carbon-intensive sectors, responsible for over 20% of global carbon dioxide emissions [1]. Better practices would significantly influence final energy expenditure, greenhouse gas emissions, and water consumption [2].

Among the proposed solutions to reduce emissions in the construction sector, there is the use of sustainable building materials, such as wood. Wood is considered an environmentally friendly material [3], a low-carbon alternative, and a sustainable housing solution [4]. Wood outperforms concrete counterparts in greenhouse gas (GHG) emissions, carbon storage [5], and carbon emissions. The use of wood helps mitigate indoor moisture, which prevents bacterial growth [6], and improves indoor air quality and thermal comfort [7]. However, the widespread use of wood as a building material is challenged as associated fire regulations are relatively strict, materials can be up to 25% more expensive [8], and consumer perception places wood as inferior in technical characteristics [3].

19th-century building technologies led to the widespread use of steel and reinforced concrete and the decline of traditional wooden structures [9]. Organizational processes and technical capabilities to work with wood are nowadays perceived as new [10]. However, the use of wood as an innovation has been scarcely studied.

In this paper, we classify wood as a building material as a preventive innovation. Rogers [11, p. 234] identified preventive innovations as those that individuals adopt to reduce the probability of an unwanted event in the future. Wood materials not only differ from concrete materials in technical and organizational requirements but also provide health-related and climate-change mitigation benefits that are preventive in nature [12].

Adopting preventive innovations in the construction sector could positively contribute toward sustainability goals. However, the adoption of innovations in the construction sector is challenging as this sector is well-known for being risk-averse [13], and path-dependent for which technological changes can take decades to be realized [14], [15]. Furthermore, incumbent organizations in the construction sector can struggle in the face of innovations. In an innovation context, incumbency refers to whether an organization participated in a previous product generation.

The purpose of this study is to explore incumbent actions in the adoption of wood materials. This study serves two objectives. First, it introduces the use of wood as a building material as a preventive innovation. Second, this study seeks to identify incumbent-related factors that influence the adoption of preventive innovations in the construction sector.

The context of this paper is an interview study where we analyzed public procurement of school buildings. In this study, we gathered narratives that illustrate the role of incumbent actions in selecting wood as a building material. Through our case, we identify the actions of incumbent organizations and identify how these relate to the preventive innovation's elements.

II. THEORETICAL BACKGROUND

A. Preventive innovations

Prevention is the action of stopping something from happening. The topic is widely covered in insurance literature [16] where utility functions are dependent on the probability of unwanted events with certain loss sizes. Loss prevention addresses the probability and severity of

the loss. “Probability” refers to the extent to which an unwanted event is likely to occur, and “severity” refers to how harmful the event and its consequences might be.

There are different ways in which individuals can prevent an unwanted event, one of them is the adoption of preventive innovations. Preventive innovations are those that individuals adopt to reduce the probability of an unwanted event in the future [11, p. 234] or to mitigate the severity of the consequences of the unwanted event. Given that preventive innovations are closely linked to the unwanted event, it seems important to consider the probability and severity of the unwanted event in the discussion of preventive innovations.

On the other side, the relative advantage of preventive innovations depends on the time lapse between adoption and beneficial consequences where desired consequences are distant in time, in comparison to non-preventive innovations [11, p. 234].

An application of preventive innovations that has not been explored is the use of wood as a building material for both health-related and climate-change mitigation and prevention [12]. In buildings, the use of wood helps mitigate indoor moisture, which prevents bacterial growth [6], and improves indoor air quality and thermal comfort [7]. Wood materials are superior at inhibiting moisture degradation through improved air circulation [17] and the risk of mold growth is low [7]. Mold exposure, dampness, and bacteria are associated with respiratory diseases [18].

On the other side, wood materials are generally considered an environmentally friendly material [3], a low-carbon alternative, and a sustainable urban housing solution [4]. When comparing wooden-framed structures in with concrete-framed structures, wood outperforms the concrete counterpart in greenhouse gas (GHG) emissions, carbon storage [5], and carbon emissions. Furthermore, after its natural cycle, wood products can be utilized as biofuels if burned [5]. However incumbent organizations can struggle in the face of innovations for which the adoption of preventive innovations can be challenged.

B. Incumbents

When an innovation is introduced to an industry, new entrants contend against well-established incumbents for market leadership. In an innovation context, incumbency refers to whether an organization participated in a previous product generation. It is well argued that incumbent organizations struggle in the face of innovations; incumbents are so devoted to their success with a particular product generation or so hindered by bureaucratic processes that they fail to adopt the innovation [19].

According to Chanty & Tellis, [19], there are three reasons why incumbents are reluctant to introduce radical innovations. First, incumbents recognize small incentives to introduce a radical product innovation as they are already getting significant revenue from existing products and technologies. Second, organizational structures that screen out information that is not relevant to an organization’s main tasks make incumbents less effective at engaging in radical innovation. Third, organizational procedures that incumbents carry out to efficiently manufacture and distribute large volumes of the current technology hinder the development of innovations.

On the other side, there are opportunities that incumbents have in comparison to new entrants. An incumbent has the best position to benefit from an innovation when success is determined by who has access to complementary assets [20]. Incumbents also have greater knowledge about customers. Furthermore, incumbents hold a strong reputation with their customer base. Finally, incumbent organizations hold market power which provides favored access to distribution channels necessary for the diffusion of the innovation [19]. In the construction sector, incumbent organizations are known for their risk aversion [13], and path dependency.

C. The construction sector

Reichstein et al. [15] and Mahapatra & Gustavsson [14] identified factors that shape the nature of innovation in the construction sector. Construction is a project-based activity where networks are impermanent and there is limited interaction among actors, which is vital for innovation. Construction is a site-specific endeavor that hinders routine development and creates uncertainty. A building’s design and size are dependent on clients, for which it is difficult to innovate in the industrialization of building processes. Furthermore, there is little competition among big contractors, for which there is no motivation to innovate [14]. Finally, the final product has a long lifespan and a big scale, for which it is difficult to test innovations before implementation.

On the other side, the construction sector is subject to path dependency and tradition. Path dependency refers to how a decision that is made in the present is affected by past decisions [14]. Path dependency deters the willingness of construction professionals to work with materials that have lower standardization than other alternatives, especially ones with which they have little expertise [14]. On the other side, the selection of building materials varies due to traditions and culture, which can be the result of the availability of materials [21].

III. MATERIALS AND METHODS

A. Research process

This study was conducted with a qualitative approach where the strategy consisted of four main steps. First, we conducted 20 semi-structured interviews lasting between 60 to 150 minutes, which served as a primary source of data. Interviewees were identified from procurement documents and further on through snowball sampling; these included professionals overseeing project management, urban services, education, and city administration. Second, we retrieved information from official documents and news pieces where we gathered additional information on the procurement process. Third, we analyzed the interviews in Atlas.ti, a qualitative data analysis software. Interviews were coded according to the research approach discussed below. Fourth, we identified

incumbent actions and how these influence the adoption of preventive innovations in this sector.

B. Context of procurement cases

We analyzed five public procurement cases from the Finnish construction sector: each case belonged to a school building that included wood as a building material. These schools were open to new construction with wood because they had indoor air quality issues with their old school buildings. All cases were selected from a region with leading status in wood construction. These cases represent various procurement processes, different award criteria, and differences in wood usage in the building as depicted in Table 1.

All cases were based in Finland and operated under the same EU regulations [22]. When this study was conducted, EU regulations allowed for eight tendering procedures; the two procedures present in these cases were open procedure and competitive dialogue. Open procedure is utilized when there are a few candidates, limited competition, and technical expertise is required. Competitive dialogue is utilized when there is a complex project but contracting authorities cannot define how to meet their needs and assess what the market can offer.

According to European Commission regulations, authorities must select the best tender following specified award criteria; typically used criteria include the most economically advantageous tender (MEAT), lowest price approach, and best price-quality ratio approach. In MEAT, the contracting party awards a contract based on various criteria other than just price, these include quality, functional, environmental, and aesthetic characteristics, among others. The lowest price approach solely considers price as the deciding factor and in the best price-quality ratio approach, the contracting party selects the tender that offers the best value for money, which also includes criteria of qualitative, environmental, and social aspects [23].

TABLE 1
OVERVIEW OF CASES

	Case 1	**Case 2**	**Case 3**	**Case 4**	**Case 5**
Procurement procedure	Open procedure	Open procedure	Compet. dialogue	Compet. dialogue	Compet. dialogue
Award criteria	Lowest price	MEAT	MEAT	Price-quality	Price-quality
Wood use in the building	Wood façade, (CLT)* interiors	Wood façade, concrete structure	Log façade, concrete structure	Concrete structure, wooden elements	Wooden logs

*CLT= Cross-Laminated Timber

C. Research approach

Through our interviews, we gathered narratives that illustrate the role of incumbent actions in the adoption of wood as a building material. In this study, we consider the municipalities that engage in the procurement of a building with wood to be incumbents. Interview data were coded to identify "why" and "what" incumbents in the Finnish construction sector are doing, and those factors relate to the probability and severity of the unwanted event and time-lapse to perceive the benefits of the innovation. Examples of coding groups include "what_probability" or "what_severity". These elements are explained in Table 2.

TABLE 2
RESEARCH APPROACH

	What?	**Why?**
Probability -of the unwanted event	1. Does the probability of the unwanted event affect what incumbents do?	2. Does the probability of the unwanted event affect incumbent motives?
Severity - of the unwanted event	3. Does the severity of the unwanted event affect what incumbents do?	4. Does the severity of the unwanted event affect incumbent motives?
Time lapse - to perceive benefits	5. Does a long timelapse to perceive benefits affect what incumbents do?	6. Does a long timelapse to perceive benefits affect incumbent motives?

IV. RESULTS

We identified incumbent actions and their relation to the probability and severity of the unwanted event and the time-lapse to perceive benefits. Synthesized findings across cases are presented in Table 3.

TABLE 3
SYNTHESIZED FINDINGS

	What?	**Why?**
Probability - of the unwanted event	Considering a highly probable unwanted event, incumbent organizations are more likely to adopt a preventive innovation.	Probability influences motives and directs incumbents toward adoption even if they are unfamiliar with the innovation.
Severity - of the unwanted event	Severe issues made incumbents willing to adopt an innovation and develop a strong attitude against the previous alternative.	Severe issues led incumbents to seek projects that were reliable, could provide good reputation overruling other criteria such as price.
Time lapse - to perceive benefits	Incumbents seek future-oriented benefits, though this does not always point towards wood.	Incumbents are deciding in favor of the preventive innovation because they are expecting benefits on the long run.

A. Probability

"What?" and "Probability"

Our findings indicate that considering a highly probable unwanted event, incumbent organizations are more likely to adopt a preventive innovation, as occurred in case 3.

While all cases had problems with indoor air quality in one of their previous buildings, case 3 had major issues with indoor air quality in three old school buildings, where schools had to be shut down and students had to be transferred. For case 3, the probability of an unwanted event was perceived as high. Therefore, the main objective for case 3 became to have a "healthy" building, as expressed by the city's mayor *"It's really the major thing that we have [a] healthy building"* (09.02.2020).

This same logic applies to unwanted events related to environmental protection as it happened in case 1. Case 1 belongs to a city that has near-future carbon neutrality goals which affect the way constructions are planned, approved, and carried out due to the high impact of the construction sector. To lower the environmental impact of construction, the main objective of the school was to be made from wood.

"Why?" and "Probability"

Our findings indicate that the probability of an unwanted event influences incumbent motives and directs them toward adopting an innovation, even if they are not familiar with it. All cases had experienced at least one problem with indoor air quality in their old buildings; and, as highlighted by the urban services director of case 2, *"the whole country is fighting with this problem"* (23.09.2020). To address this problem, all cases considered building with wood even though they were not sure of its benefits, as highlighted in the quote *"some people think that in wooden schools, the indoor air would be better […] I've read articles about it as well. But I don't know if it's actually something that is scientifically proved or anything"* (urban services director, 23.09.2020).

B. Severity

"What?" and "Severity"

In this aspect, we found that health-related issues were considered highly severe, and this made incumbents willing to adopt an innovation that had shown better results than the current alternative. Furthermore, incumbents developed a strong attitude against the previous alternative that had caused consequences.

This is clearly illustrated in case 2, where there were indoor air quality issues in three schools. Incumbents avoided the use of certain materials, such as plastic, as stated by the city's mayor *"we were doing everything to not choose plastic materials that cause some problems"* (02.09.2020) and mentioned that they seek to have a good image and the use of plastic could disturb it.

"Why?" and "Severity"

We found severity to help incumbents seek to implement reliable projects, could provide a good reputation, and could be done promptly. As portrayed in case 2, when the matter needed to be solved urgently, as discussed by the technical director *"[there were] serious health problems and threats that they [schools] had to be closed and procured with great urgency"* (29.11.2019). The project had a such priority that it overruled the price criterion, which was *"millions more than if it has some other material"* (technical director, 29.11.2019).

For case 3 health problems were not the only issue, but also the bad reputation that came alongside, as depicted by the urban services director when describing another school that had problems with indoor air *"they can't get rid of the reputation that they're having problems with the schools"* (23.09.2020). In this case, incumbents wanted a solution that gave a good reputation, and as recalled by the interviewee *"I think the image for wooden school helps for that"* (urban services director, 23.09.2020).

C. Time lapse to see benefits

"What?" and "Timelapse"

When we studied the influence of a long timelapse to see benefits we identified that incumbents seek future-oriented benefits, though this doesn't always point toward wood materials. For example, in case 2 other options besides wood, were analyzed as the durability of wood was questioned, as said by the mayor *"concrete construction still had supporters, because this (wood) and the durability of wood that it would last 50 years as an example was not necessarily believed"* (09.02.2020). However, wood was chosen as the priority was to have a healthy school.

"Why?" and "Timelapse"

When we looked at how a long timelapse to see benefits affects incumbent motives we identified that incumbents are making some decisions because they are expecting benefits in the long run. For example, incumbents from case 1 *"wanted to prepare for the future"* (project architect, 15.11.2019) by selecting a material that would cater to future environmental regulations in the construction sector. While environmental benefits take a long time to be realized, being prepared for upcoming environmental regulations appeared as a benefit realized in the present.

V. DISCUSSION AND CONCLUSIONS

In this paper, we studied decisions on the adoption of wood materials, categorized as preventive innovations. Our findings indicate that the probability and severity of an unwanted event that has already been experienced make incumbents more likely to adopt the preventive innovation. Regarding time-lapse, it appears that future-oriented benefits are not a deterrent for adoption and in fact, future benefits are often utilized to argue for potentially larger investments. We identified that preventive innovations can also bring immediate benefits, particularly in the form of a good reputation, being prepared for the future, and health benefits. Preventive innovations are often characterized as having a long timelapse from adoption to seeing benefits; however, future-oriented benefits could be a good fit for sectors with long-term projects, such as the construction sector.

This study contributes to diffusion studies, on the adoption of preventive innovations. This paper dealt with the probability and severity of the unwanted event in an exploratory fashion as these elements have not been covered in previous studies of preventive innovations. Findings highlight the role of probability, severity, and time lapse to perceive benefits. This study expands the domain of preventive innovations by applying the concept to the construction sector and broadens knowledge on

"innovations", "wood construction" and "prevention" within construction sector literature.

On the other side, our findings contribute to the body of knowledge on prevention within the construction sector by presenting a different application to this concept: prevention-related benefits derived from building materials. While the environmental and health benefits of WMC have been identified previously [8], these have not been considered through the lens of prevention. Recognizing the preventive quality of wood construction could shed light on how to influence its rate of adoption.

This study has its limitations. The elements identified in this study cannot be generalized, as they belong to the scope of public procurement of school buildings in Finland. This study analyzed incumbents in the public sector, which has responsibilities in terms of community, democracy, economy, and wellbeing well-being [24]. Therefore, it is the responsibility of municipalities to provide conditions for the well-being of their residents, which might not be the case for other incumbents facing the decision of including wood in construction projects. Future studies could analyze willingness to adopt when incumbents have not experienced the unwanted event; this could also illustrate the role of past experiences on current decisions. Furthermore, future work seeks to identify the presence of probability and severity of an unwanted event quantitatively, as these were covered in an exploratory fashion in the present work.

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